(1) Inception Report ..... Fifty (50) copies dated April 1992
Submitted in the beginning of the Phase I - Field Work (I)

(2) Plan of Operations ..... Fifty (50) copies dated August 1992
Submitted in the beginning of the Phase II - Field Work (II)

(3) Progress Report ..... Fifty (50) copies dated March 1993
Submitted at the end of the Phase II - Field Work (II)

(4) Interim Report ..... Fifty (50) copies dated August 1993
Submitted in the beginning of the Phase II - Field Work (III)

(5) Draft Final Report ..... Fifty (50) copies dated August 1994
Submitted by the international courier service in November 1994.

(6) Final Report ..... One hundred (100) copies dated March 1995

Presented after incorporating all of the revisions based on the comments on the Draft Final Report and related items as discussed during the Field Work (IV).

1. 5. 6 Acknowledgements

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  - Dr. F. I. Soribe, Director of Planning, Research and Statistics

- Dr. F. I. Soribe, Director of Planning, Research and Statistics
- Mr. J. A. Hanidu, Director of Hydrology and Hydrogeology
- Mr. Sadiq Mahamood, Director of Dams and Reservoir Operations
- Mr. I. K. Musa, Director of Irrigation and Drainage
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CHAPTER 2. OVERVIEW OF THE PROBLEMS: CONSTRAINTS AND POTENTIALS

2.1 WATER RESOURCES MONITORING AND RIVER MANAGEMENT

2.1.1 Climatical Data

(1) Rainfall

There are some 1,070 rain gages operated by FDMS, RBDAs, SWAs and others throughout the country, of which 484 gages or 45 percent of the total with the record of more than five years are maintained generally in good condition. The Study Team has collected the monthly rainfall data of 20 years (1970 to 1989) at 213 gages, of which 89 gages have been selected in view of the data reliability and need for the NWRMP Study.

Agencies	FDMS	RBDAs	SWAs	State Ministries	Educational Establishment	Others	Total
No. of Rain Gages	79	62	107	83	39	114	484

	HAs								Total
	I	II	III	IV	V	VI	VII	VIII	
No. of Rain Gages Employed for NWRMP	8	19	27	4	5	11	6	9	89

Generally speaking, the management of rain gages for observation and subsequent data processing is in rather unfavorable situation with the less priority placed except for the FDMS where the recorded papers are kept without any compilation of the monthly and annual totals. In addition, there are scarce gages in and around existing water resources facilities and works which have hampered the effective operations and efficient management for the water resources so far developed to a large extent.

(2) Evaporation

Only 23 gages with the long-term record have been inventoried nationwide, of which four gages are managed in the North Region so far

that number of the gages and their management in total are not satisfactory for the pressing needs.

2.1.2 Surface Water Data

(1) Discharge

Although there have been many issues on number of the hydro gages throughout the country, the JICA-NWRIS has reported the current existence of 358 gages being composed of 48 automatic water level recorders and 310 staff gages. Of these, the continuous observation of the water level is maintained at 173 gages, of which only 65 gages or 38 percent of a total are available for the discharge measurement with the record of more than five years while it is reported that the discharge measurement is carried out at 119 gages.

Agencies	FMWRRD	RBDAs	SWAs	FIWD	NEPA	Other	Total
No. of Hydro Gages	59	89	148	44	14	4	358

	Along the Niger	Along the Benue	HAs I	II	III	IV	V	VI	VII	VIII	Total
No. of Hydro Gages Employed for NWRMP	7	4	7	3	11	2	-	7	11	13	65

It has been observed that many of the gages registered are difficult for the operations due to the breakage of equipment, river channel variations and lack of budget. In particular, the lack of updating the old rating curves and subsequent data processing has made it difficult to grasp the potential surface water resources at an accurate level and also to establish the project feasibility and operate existing water resources facilities and works at a sufficient level.

(2) Water Quality and Sediment Transport

At this stage, there is a complete lack of observation for water quality and sediment transport in the surface water. This fact has made it impossible to evaluate the present situations of both items on quantitative basis.

It appears that the surface water would have been contaminated by agricultural chemicals, industrial effluents and domestic wastes to a considerable extent as a consequence of rapid population growth; however, there would be no particular problem on the water quality observed at existing reservoirs for water supply.

It is quite evident that the recent land degradation problems as are explained in para. 1. 4 have caused the rivers to concentrate more sediment transport load, from watersheds, and the occasional sediment deposits along the river courses have resulted in the frequent occurrence of the local flooding and inundation in the urban low-lying lands. Although there is no report on particular damages at this stage, a rapidly increasing amount of the sediment transport will be a bottleneck for sound river management in future.

2. 1. 3 Groundwater Data

Groundwater abstraction has been made in a form of deep wells or boreholes by various organizations mainly for domestic water supply. Each of the organizations appears to act independently except for the minimum inter-departmental coordination. An attempt has been made to prepare the nationwide inventory on number of deep wells and their major dimensions through the JICA - NWRIS, as summarized below:

	NW HA-I	NE HA-VIII	CW HA-II	CE HA-III/IV	SW HA-VI	SE HA-V/VII	Total
1. Total Number	5,320	6,760	3,340	2,640	4,080	1,090	23,230
2. Depth of Wells							
More than 100 m	640	990	100	80	460	550	2,820
50 ~ 100 m	1,870	2,080	690	300	430	350	5,720
Less than 50 m	2,280	2,830	1,800	2,170	3,000	80	12,160
Not specified	530	860	750	90	190	110	2,530
3. Groundwater Yield							
More than 100 ℓ/min	2,530	1,300	910	-	430	600	5,770
50 ~ 100 ℓ/min	370	1,170	340	10	280	20	2,190
Less than 50 ℓ/min	1,370	2,680	750	2,540	2,640	10	9,890
Not specified	1,050	1,710	1,340	90	730	460	6,380

Up to date, some 23,000 deep wells have been provided throughout the country, more than 50 percent of which are concentrated in the North Region. When compared with the potential groundwater resources as stated in para. 1.3, there is no problem of the groundwater balance between recharge and

withdrawal on regional basis except for the local areas of Maiduguri, Sokoto and Lagos. The former two have suffered from overpumping to meet the demand of rapidly expanding urban area, hence, lowering the groundwater table, while the demand of latter from water quality deterioration by salinization.

Little attention is presently paid to the quality of groundwater which is unlikely to be a reason for rejecting its use, because the maximum emphasis has been placed upon improving the water supply availability and quantity. In general, the groundwater quality is satisfactory for drinking water; however, some remarks should be made to the South-East Region for acidic water (pH 5 to 6), the Lower Benue trough for saline water pockets in fractured shale aquifers, the coastal area for seawater intrusion, and the majority of manpower-operated wells for frequent pollution.

2.1.4 River Management

Since the river management in well-coordinated manner produces the benefits to regional and national economy, it is in principle a Government task. In 1975 when the defunct FMWR was initially created, the responsibility of nationwide river management administration has not been attached to the said Ministry, while the FIWD for inland navigation is still responsible for the management of the Niger and the Benue. Prior to August 1993 when the Water Resources Decree was promulgated, there was virtually no single agency who is responsible for an integrated river management on use and conservation of the water resources and river systems.

Reference is made to the watershed management in Nigeria where the lack of proper coordination between the river management and administration is recognized. The watershed management may be defined as natural counterpart of soil conservation and reforestation which are closely connected with the river runoff and sediment discharges. The main Federal institutions concerned with this program are the FMANR and the FEPA, and positive involvement of the FMWRRD should be materialized to strengthen the activities of watershed management program.

2.2 COMPONENTS OF THE WATER RESOURCES SECTOR

2.2.1 Water Source Works

(1) General Overview

River runoff over Nigeria is definitely seasonal with the wet season occurring between July and September in general; accordingly, the dam and reservoir are basically required to utilize the surface water throughout the year for irrigated agriculture, domestic and municipal water supply and hydropower generation.

As of 1991, the number of dams as completed or under construction has reached 160 sites with a total effective storage of 30.7×10^9 cu.m:

	NW HA-I	NE HA-VIII	CW HA-II	CE HA-III/IV	SW HA-VI	SE HA-V/VII	Total (%)
1. Number of Dams							
Irrigation	10	17	12	11	11	10	71 (44)
Water Supply	9	6	18	21	21	8	83 (52)
Hydropower	1	0	2	3	0	0	6 (4)
Total	20	23	32	35	32	18	160 (100)
2. Active Reservoir Capacity (10^6 cu.m)							
Irrigation	1,725	5,885	489	2,225	840	0	11,164 (36)
Water Supply	44	66	441	139	213	2	905 (4)
Hydropower	11,500	0	7,050	49	0	0	18,599 (60)
Total	13,269	5,951	7,980	2,413	1,053	2	30,668 (100)

For the hydropower, the large-scale dams and reservoirs at Kainji and Jebba along the Niger and at Shiroro along the Kaduna have been constructed by the NEPA, while the NESCO is operating the local mini-hydropower in the Jos Highland with the construction of nine small-scale water storages. General observation indicates that the hydropower generation as mentioned above is well-functioned in spite of the obsolescence of equipment.

The water storage dams for irrigation and water supply have been constructed throughout the country. In the North Region, there are many large-scale dams constructed since the onset of Sahelian drought which occupy their active reservoir capacity of 7.7×10^9 cu.m or 63 percent of the nation's total for these objectives. The Central and South-West Regions have in general many medium and small-scale dams with some large-scale ones, while there

are only small-scale dams with the function close to diversion dam in the South-East Region. It may be noted that the current water use rate of these existing reservoirs is quite low at 10 to 20 percent in general because the downstream facilities for conveyance and distribution have been in slow progress for construction mainly due to the lack of reservoir water operations rule.

(2) Problems and Constraints

(a) Reservoir Water Operations

- Excessive reservoir capacity against its inflow:

  This is applicable to some dams in the North Region and has been the result of insufficient feasibility study including hydrological analysis and project planning.

- Large evaporation loss from reservoir surface:

  In the North Region where the rather flat topography created the extensive reservoir area, the evaporation amounts to 20 to 30 percent of the active reservoir capacity, and this may hamper the effective utilization of the limited scarce resources.

- Downstream release of reservoir water:

  It appears that there is the lack of consideration on the reservoir water operations to satisfy the downstream requirements other than the Government public schemes. A critical example is the Hadejia-Nguru wetland which requires the artificial flood release from the upstream dams in the wet season to maintain various water use of the indigenous activities.

- Water availability of existing reservoirs:

  The JICA Team has attempted to evaluate this on a preliminary basis taking into account the carry-over for dry year, excessive evaporation loss and downstream water demand. In particular, a preliminary analysis of the reservoir operations for 11 representative cases in the North and Central -East Regions has been conducted to estimate the water availability, on the base of which the following have been compiled:

(unit: 10^6 cu.m)

	NW HA-I	NE HA-VIII	CW HA-II	CE HA-III/IV	SW HA-VI	SE HA-V/VII	Total
1. Active Reservoir Capacity	1,750	5,940	940	2,340	1,030	50	12,050
2. Possible Water Use	980	2,120	790	1,620	890	60	6,460
(1) Irrigation	580	1,120	380	1,160	490	30	3,760
(2) Water Supply	130	270	330	200	350	30	1,310
(3) Downstream Environment	270	730	80	260	50	0	1,390
3. Water Use Rate: 2/1 (%)	56	36	84	69	86	120	54

(b) Slow Utilization of Reservoir Water

As is explained in the above table, the nationwide water availability of existing reservoirs for irrigation is $3,760 \times 10^6$ cu.m and for water supply $1,310 \times 10^6$ cu.m. On the other hand, the assumed nationwide water use for irrigation and water supply at this stage is 350×10^6 cu.m and 620×10^6 cu.m respectively. Comparison of the both figures indicate considerable gaps between the construction of dams and the actual water use in the downstream service areas which may imply unfavorable return from the huge investment for the dams.

(c) Dam Safety

There are apparent technical defects at many of existing dams including the seepage through dam foundation works, shortage of spillway flood capacity, decrease of effective storage due to excessive sediment inflow, damages of gates and valves due to reckless operations, extraordinary vegetation growth and severe erosion on dam slopes, extensive aquatic weed development over the reservoir area and so on. When nothing is done for these dam safety problems and related upkeep of dam functions, such dams may constitute a significant potential hazard to the downstream people and societies.

(d) OM

While OM for large-scale dams is being carried out to a certain extent, many of the small and medium-scale dams are facing the difficulties due to the lack of technical data, equipment, access road, skilled manpower, etc. for OM.

(e) Environmental Issues

It is inconceivable that a systematic environmental impact consideration was carried out for any of the dam and reservoir projects, and it has been pointed out that the water and environmental quality monitoring is a very neglected activity in these large social investments that may greatly change the pre-existing environment including the disturbance of various riverine ecosystems, the interception of fish movement up and down the stream, and so forth. In addition, there is the watershed deterioration that is progressing at an alarming rate and may lead towards the reduction of reservoir life-span and the enlargement of dam spillway capacity.

2.2.2 Irrigation and Drainage

(1) General Overview

The general consensus is that the food and nutrition insecurity is a serious and growing problem in Nigeria since 1985 when the FGN banned the imports of main foodstuff. Before this, the food imports rose sharply as domestic production failed to meet the demand of a population growing not only in size, but becoming more urbanized and affluent. While the prospect for raising agricultural production by bringing more area under cultivation is quite limited, great emphasis has been placed upon the irrigation development for growth in production.

At this stage, there are the public sector schemes by RBDAs under the FMWRRD administration and by the State Ministries and the private sector programs by the State ADPs mostly under the coordination of the FMANR. The former consists of large, medium and small-scaled projects, most of which have the upstream reservoirs, and the latter of the farmer-owned and-operated small irrigation in the wetlands. To date, the upstream construction in the public schemes is completed for the irrigable area of 320×10^3 ha while the downstream construction to on-farm level has reached only 70×10^3 ha or 22 percent of a total. On the other hand, the private program has been identified by the FGN as a key source of agricultural growth with a positive support of the World Bank with the achievement of 150×10^3 ha under irrigation.

(unit: 10^3 ha)

	NW HA-I	NE HA-VIII	CW HA-II	CE HA-III/IV	SW HA-VI	SE HA-V/VII	Total
1. Public Irrigation Schemes							
Planned Area	60	90	55	40	45	30	320
Serviced Area	8	27	12	12	3	8	70
Achievement (%)	13	30	22	30	7	26	22
2. Private Irrigation Programs							
Serviced Area	35	98	10	3	-	4	150

(2) Problems and Constraints

Experience with irrigation development in Nigeria demonstrates that this sector is suffering from a number of technical, financial, institutional and human resource weakness. Many problems facing the existing public irrigation schemes have been identified:

(a) Incomplete Public Schemes

i) Ambiguous Scope of the Project Service Area:

The Study Team has evaluated the irrigable area for existing incomplete schemes at 320×10^3 ha taking the account of water availability at their upstream sources while the JICA-NWRIS has recorded at 450×10^3 ha. This evaluation has led to the decrease in service area for the following major large-scale projects:

(Unit: Service Area, ha)

HA	Project	Initially Planned	JICA-Evaluated	Major Reasons
I	Zobe Dam	8,200	5,200	For water supply to Katsina.
I	Goromyo Dam	21,000	17,000	Less water availability.
III	Dadin Kowa	38,000	-	Service area not identified.
III	Balanga	4,000	2,800	Less water availability.
V	Lower Anambra	5,000	3,000	Incomplete water source works.
VIII	KRPII	40,000	4,000	Less water availability.
VIII	Baga	20,000	1,000	Lowering of the Lake Chad water level.
VIII	South Chad	67,000	22,000	- do -

It is general that the irrigable area proposed under existing water source works would be roughly shown without examining the relation of both the source availability and irrigation demand, and also even the delineation of service boundary.

ii) Inadequacy of Project Feasibility Study:

The review of previous project feasibility study reports indicates that the majority lack proper preparation of topographical map, soil and land classification survey, existing agro-and socio-economic survey and so forth which are the pre-requisite in project planning. It is suggested that the feasibility of a large-scale project should be discussed in line with the international procedures and standards as already established. In addition, there should be the need to prepare the guidelines and criteria on cropping patterns, irrigation method and water demand, and project benefits (financial and economic) which constitute the main parts of the project study. To promote the quick preparation of project planning in more consistent manner, these guidelines should be established preferably on regional level.

iii) Remarks on Project Design and Construction:

Taking into account the current problems involved in these subjects, there is also the need to establish the guidelines and criteria on design procedures for relevant structures, the cost estimate, and preparation of specifications and tender documents for construction. In designing the water conveyance from the water source works to the irrigation area, maximum effort should be made to adopt a gravity system. It is common that the construction works for large project be carried out by contractor through competitive bidding procedures without the use of expensive contractor financing. In this respect, the FMWRRD and RBDAs should pay more attention to the issue of costs for the projects which are prepared to attract the concessional finance from international and bilateral sources. In the case of small-scale projects, there is a great potential of introducing the construction works on force account basis where the procurement of construction machinery, positive participation of farmers and staff training are carefully examined.

(b) Complete Public Schemes

i) Improper OM for Project Facilities:

It is the general feature that the water operations along the main / secondary canals, at the night storages and at on-farm level are not conducted in smooth and adequate manner; in particular, on

preparation of the rotational irrigation schedule by irrigators groups and water distribution plan at farm turnouts, and operations of the bifurcation structures for substantial improvement. As far as the maintenance is concerned, there are problems on the shortage of canal water conveyance capacity in gravity, facility deterioration or already damaged, reduction of conveyance capacity by silting and weed growth and so on which need urgent rehabilitation and regualr maintenance and repair works.

ii) Slow Progress in Irrigated Agriculture:

Apart from the OM of facilities, success in irrigated agriculture largely depends upon the adequate provision of agricultural extension service and the vigorous activities by sound Water Users Associations (WUAs). The agricultural extension is in a state of transition currently with the RBDA services being replaced by the ADP; however, the coordination between the two is generally insufficient. Although there are various problems of building up the irrigated agriculture including positive farmers participation, the WUAs are presently being organized on existing schemes; however, whether these can be induced to play a practical role in OM would be a matter of conjecture.

It may be noted that the land tenure strategy in irrigation schemes is mixed. In most cases, the land is provided by the government to farmers under various tenancy arrangements, generally on seasonal basis where the sense of farmers' land ownership is lacking and the plot distribution procedures cause the constant delays in starting cropping operations which are hampering the smooth progress of irrigated agriculture. In some schemes where the farmers' pre-existing rights are respected, the land consolidation or geometricization works by the Government are introduced to facilitate water management and farm mechanization during project implementation; however, this is too early for introduction in view of high cost for major land levelling and immaturity of the farmers for subsequent operations.

(c) Favorable Situation of the Private Schemes

In contrast to the spotty record of public sector schemes with many problems, a pervasive theme emerging from recent experiences in Nigeria is the relatively successful record of small-scale private program over the

wetlands, most of which are through the smallholder initiated motorization of lift irrigation on the borders of rivers, lakes and shallow-dug wells for small plots within 100 m of the water source. The importance in the success in this type of farmer-owned and - operated irrigation is that it demonstrates that the farmers are prepared to make, what are to them, substantial capital investments to improve their farming operations when the returns are high and the assets purchased are easy to realize. Although the availability of surface water and shallow groundwater over the wetlands is the long-run constraints on the expansion of this private program, the World Bank is taking a very positive attitude to support this with the National Fadama Development Project initiated in 1992 and also appropriate follow-up activities.

(d) Environmental Issues

It appears that the environmental aspects of public irrigation development in Nigeria are much as the same as in most tropical countries involving public health, fisheries, aquatic weeds, downstream hydrology, agricultural chemical management, drainage and social issues, although not quantified in detail. Most of the large-scale public sector schemes have created serious social problems where the most disadvantaged were families displaced by reservoirs and other infrastructures or rejected for application when the agency acquired the area to be irrigated and leased the plots to selected applicants. Compensation was paid to those who lost the use of land only for the loss of crops and other improvements; however, the resettlement of those families was not organized being subject to their own devices.

2.2.3 Water Supply and Sanitation

(1) General Overview

Water supply schemes in major cities were started in Abeokuta (1911) by the colonial administration with a key role that the improved water supply could play in the elimination or control of common diseases and in the raising of health level and general welfare of people. By 1970, there were 261 urban water supply undertakings. Since early 1970s, the Governments have invested heavily in urban water supply schemes including the reservoir construction and borehole sinking for State capitals. At this stage, it may be understood

that inadequate water supply remains as one of the major problems in urban centres, in fact, the supply of improved water can be said to be adequate in none of them.

Until recently, virtually all the States gave a relatively low priority to water in their rural development efforts, and in many areas, the rural people regard water more in terms of convenience than of health benefits. Many tubewells were sunk in the North Region in the 1940s to early 1960s without active involvement of the local people; thus, the people were not made to accept to take care of them. With the establishment of RBDAs in 1976 and DFRRI in 1986, a new era opened in the provision of rural water supply, and a great number of boreholes have been sunk in various parts of the country. Because of inadequate supply, technical problems and peoples' ignorance, many of the rural communities served in this way have not derived the maximum benefits.

Nigeria was one of the signatories to the International Drinking Water Supply and Sanitation Decade (IDWSSD) whose objective was to supply water to all citizens of the country for the period of 1981 to 90. In spite of this, the water supply situation appears to be deteriorating; as a result of increasing population and no commensurate increase in service level, Nigeria is gradually becoming one of the countries with the lowest level of water supply services in the world. In order to evaluate the present water supply service level, the JICA Team has made a considerable effort through proper interpretation of the limited available data and assumptions to a large extent to complement the lacking data; to this end, the following major indicators for water supply situation as of 1991 mainly based on the data collected for water intakes at LGA level taking into account the diversion of surface water and the groundwater withdrawal have been obtained as a basic requirement to be involved in the NWRMP Study.

Urban Water Supply		NW HA-I	NE HA-VIII	CW HA-II	CE HA-III/IV	SW HA-VI	SE HA-V/VII	Total or Average
(1) Total Population	(10^3)	4,261	6,836	5,941	4,034	16,552	11,432	49,055
(2) Existing Intakes								
2.1 Service Population Planned	(10^3)	3,135	6,129	5,643	2,093	15,540	6,364	38,904
2.2 Intake Capacity Provided (MLD)		440	598	740	286	1,523	612	4,199
2.3 Per Capita Capacity, (2.2)/(1)	(ℓcd)	103	88	125	71	92	54	85
(3) Actual Water Supply Capability								
3.1 Intake Capacity Available	(MLD)	250	344	516	161	988	379	2,639
3.2 Per Capita Capacity, (3.1)/(1)	(ℓcd)	59	50	87	40	60	33	53
(4) 1991 Service Level								
4.1 Per Capita Demand Assumed	(ℓcd)	88	99	106	92	134	89	108
4.2 Service Population, (3.1)/(4.1)	(10^3)	2,836	3,402	4,626	1,767	7,318	4,311	24,260
4.3 Service Population Rate, (4.2)/(1)	(%)	67	58	82	44	45	35	50
Rural Water Supply								
(1) Total Population	(10^3)	6,070	9,932	4,555	5,633	5,778	7,494	39,462
(2) Existing Intakes								
2.1 Service Population Planned	(10^3)	848	1,221	650	719	1,041	570	5,069
2.2 Intake Capacity Provided	(MLD)	34	49	25	29	34	23	194
2.3 Per Capita Capacity, (2.2)/(1)	(ℓcd)	6	5	6	5	6	3	5
(3) Actual Water Supply Capability								
3.1 Intake Capacity Available	(MLD)	24	34	18	21	24	17	138
3.2 Per Capita Capacity, (3.1)/(1)	(ℓcd)	4	3	4	4	4	2	3
(4) 1991 Service Level								
4.1 Per Capita Demand Assumed	(ℓcd)	40	40	40	40	40	40	40
4.2 Service Population, (3/1)/(4.1)	(10^3)	610	850	437	525	600	430	3,453
4.3 Service Population Rate, (4.2)/(1)	(%)	10	9	10	9	10	6	9

Currently, separate water supply considerations have been made for three socio-economic profiles of the population - urban (more than 20,000), semi-urban (5,000 to 20,000) and rural (less than 5,000) according to the access and extent of such amenities as electricity, piped water and paved roads. Urban systems typically use surface water and groundwater sources with the piped system, house connection and yard taps, in which the surface sources require the treatment plants. Semi-urban is mainly based on the use of mechanized deep well schemes with piping to yard taps and public standpipes. Rural water supply generally includes the use of handpump-equipped boreholes and wells.

Virtually, there is no clear-cut policy on sanitation which has always been regarded as a household affair with the exception of existing public sewerage systems for part of the urban area in the large cities such as Port Harcourt, Lagos, Ibadan, Kano and Abuja provided since 1978. The present major technology endorsed for urban area is the household water system connections to conventional public sewer or private septic tanks; the semi-urban uses the household water system connections to private tanks and ventilated improved pit (VIP) latrines; and the rural area uses the VIP latrines and pour flushes. It is assumed that the sanitation coverage would be normally

below that of the water supply, and the domestic water waste disposal practices are virtually unregulated and undeveloped in most areas of Nigeria resulting in the contamination and deterioration of both the surface and groundwater quality.

(2) Problems and Constraints

(a) General

Poor coverage for the water supply and sanitation is linked to the following:

- Improper targeting of the resources in planning with most data used being arbitrary.
- Lack of capital to complete water projects and initiate new ones.
- Lack of funds for operations and management.
- Inadequacy of skilled labor management and optimization.
- Insufficient billing and collection of water revenue needed for OM.
- Inadequate monitoring and evaluation of the performance.

(b) Problems in Planning the Urban Waterworks

The existing waterworks by surface water particularly for large-scale ones have been initiated with the plan of over-designed supply capacity based on the long-term demand projection. Actual water supply level is quite low resulting in high costs for OM of the treatment plants and also in their quick deterioration due to insufficient OM fund. It may be noted that the large-scale waterworks should be constructed in stage-by-stage manner in accordance with the short-term demand projection and also may be divided into a series of the small-scale ones for risk dispersion if possible.

(c) OM for Urban and Semi-Urban Water Supply

In practice, most piped systems only work intermittently, largely because of inadequate funds to operate the systems and the lack of qualified manpower to maintain the relatively complex installations. In addition, there is the need of rehabilitation of existing systems and putting efficient revenue

collection and OM procedures in place. It may be mentioned that if the water supply is regular and reliable, the revenue collection system at least to cover OM cost would be accepted as it has been in the countries that are even more economically distressed than Nigeria.

(d) OM for Rural Water Supply

The building of institutional capacity may be the most important factor for sustainable rural water supply. In particular, the community ownerships of such facilities are a key factor, while the role of the Government should be limited to support such functions as training village operators in routine maintenance and repair works and assisting in the establishment of private distribution and stocking of spare parts.

(e) Lack of the Water Quality Standards and Monitoring

Nigeria has no national water quality standards, and none of the SWAs is known to have established its own standards. The WHO guidelines remain as the only reference indicating that those for drinking water are being routinely met in most of the large-scale water treatment plants. Apart from the groundwater quality that is generally good for drinking with some exceptions, the surface water would be highly contaminated by indiscrimate disposal of the wastes, water-borne diseases, eutrophication, fine sediments and so on with many visibly polluted rivers in South Region. As a matter of fact, there is no national water quality monitoring agency which currently initiates, executes or coordinates water quality monitoring and data gathering and related activities.

2.2.4 Gully Erosion Disaster

(1) General Overview

It is stressed that all of the States are adversely affected by soil erosion, but the intensity and types vary from region to place. Gullying which is the most observable and frightful type of erosion is in very sharp contrast to the situation of sheet erosion. Although the gully erosion can be found commonly throughout the country, the most catastrophic gullyings are seen in

the States of Anambra and Imo where it has been explained that a gully can start off without warning in a rainy night and, within a few months, grow into a monumental gash 100 m long over 20 m wide and 15 m deep.

It appears that the gully erosion disaster occurrs in the area with a combination of weak, sandy soils, widespread deforestation and heavy rainfall runoff from several forms of the careless resource uses and development works such as road buildings, housing and urban-related works along the critical slopes and disturbed land particularly in line with the encroachment of urban area on rural fringe where no drainage system or poorly-designed system for the disposal of heavy surface runoff is provided. From this point of view, the gullying may be defined as a man-made disaster.

It is reported that the gully occurrence started since the 1920s and has been accelerated since the 1970s due to the rapid progress of urbanization. In spite of the fact that a total area damaged by gullies is certainly less than 0.1 percent of the country's total, the number of gullying sites is surprisingly large and the size of some individual gullies is quite enormous particularly in the South-East Region. Since the gullying inevitably increases with time in number and size, the JICA-NWRIS could not identify all of the present situations. There is the available record that the number of gullyings under the territory of A-I and CRBDAs was about 500 as of 1993, while the number of active gully complexes in the States of Anambra and Imo checked by the FMWH in 1989 was 550. In addition, active gullies are seen in the Jos Plateau and other Savannas.

In this NWRMP Study, a serious attention has been paid to the gully erosion disaster problems in view of the adequate countermeasures for the water resources conservation in line with the activities of the Department of Soil Erosion and Flood Control, the FMWRRD. This Department deals with the control of gully erosion in terms of civil engineering works, while the Departments of Agricultural Land Resources and Forestry, the FMANR are concerned with the land resources management including the soil conservation operations particularly in agronomic terms. The overall program and priorities for soil conservation operations are currently decided largely by the National Committee on Ecological Problems which administers the Federal Ecological Funds used to support environmental and conservation programs. A Sub-Committee on Erosion and Flood Control allocates such Funds for gully control.

(2) Problems and Constraints

(a) General

The human activities have contributed immensely to the gullying problems, translating what would have been a process under the natural cover of vegetation into a serious calamity in particular areas, among which are:

- Poor sense of gullying problems by local people owing to the lack of land ownership resulting in easy resettlement to other areas when the gullying started.
- Road construction without adequate attention to the provision of safe side drains or any cross drains at all.
- Ill-designed channelization of heavy rainfall runoff especially in built-up areas.
- Indiscriminate destruction of vegetation cover or reckless selective removal of plant species through fuelwood collection, establishment of construction sites and other activities.

Anti-erosion measures have varied widely in scope and in effectiveness including those from the public education campaign to the legislative provisions on bans of gully-inducing activities and remedial measures comprising exclosural zonation, population resettlement, structural alternation and community surveillance. However, the present situation has not yet gone out of hand in many locations across the country.

(b) Technical Problems in Gully Control Works

At present, many of the gully control works are being designed and constructed mainly by RBDAs. It may be mentioned that the situation of some works have been worse than the problem had been prior to construction in the sense that an attempted solution has precipitated an even worse disaster. The following are the major problems summarized:

- Inadequate consideration of geology, hydrology and hydraulics in the project design and engineering.
- Insufficient budget allocation causing the control projects to be suspended or abandoned on the way.

- Time delays between the gullying in rainy season and the construction in dry season including the period of design work, during which the gullying is developed and expanded causing the design and layout to be obsolete.
- Use of ineffective materials for construction works which would not be tolerated against the flow of rainfall runoff with much sediments.
- Lack of the post-control maintenance for drainage system after passage of the sediment-laden flow because of institutional and budgetary defects, and also for proper vegetation growth which may be hindered by poor ground surface in quality and less rainfall in dry season.

(c) Impact of Gully Erosion Disasters

It appears that the problem of gully erosion is of grave local concern where it does occur, and at most 5 million people might be affected in some manner, many of whom have the limited access to other land resources. It is, however, recognized that the localized impact could be significant, and a high priority at a State or regional level might be placed on this disaster. Apart from its agricultural impact, the gully erosion affects the Nigerians in numerous other ways which include:

- further damages to and often total loss of residential buildings, schools, other public infrastructure, patches of forest and wildlife habits, visual amenities, etc.
- accelerated siltation of river channels downstream of gullying, thereby endangering sources of water supply, reducing the life-span of water storages, impeding inland transportation, disturbing aquacultural and related production system, etc.
- urgent measures of the enforced and expensive population resettlement as well as the realignment, relocation or reconstruction of public structures.

2.2.5 Other Water-Related Components

(1) Hydropower Generation

At present, a total aggregate of the capacity installed at power plants under the NEPA is 6,000 MW (1,900 MW of hydro and 4,100 MW of thermal) with the nationwide power grid system of over 3.7×10^3 km of 330 KV lines and about 40×10^3 km of 132 KV lines covering nearly all the State capitals. In addition, there are other organizations concerned with power generation which include the NESCO operated in Plateau State, the State Rural Electricity Boards running small-scale thermals in remote areas and the private companies and individuals which maintain the assumed aggregate of power plants at about 2,500 MW.

Out of the 6,000 MW installed capacity under the NEPA, barely 2,500 MW would be available because there are major breakdowns in plant machinery and equipment which have not been repaired either due to the non-availability of fund to procure much needed spare parts or delay in negotiating with contractors who are to carry out the works. Furthermore, most of the NEPA distribution networks are virtually overloaded resulting in frequent breakdowns and outages. It appears that if nothing is done, the NEPA would be no longer in a position to cope with the increasing power demand judging from the incessant power failures and the frequency of interruptions.

The current status of three major hydro plants under NEPA is briefed below:

Plant	Capacity		Current Status
	Installed	Available	
	--- MW ---		
Kainji (8 units) - 1969 -	760	500	- 5 units are functional. - all units are due for overhaul.
Jebba (8 units) - 1984 -	540	540	- Spare parts required for routine maintenance.
Shiroro (4 units) - 1989 -	600	450	- One unit under repair.
Total	1,900	1.490	

Aside from the Shiroro hydro located on the Kaduna river, the Kainji and Jebba schemes both on the Niger are currently suffering the decrease of inflow into

the reservoirs mainly due to the Sahelian drought over the catchment areas. When the White Flood from the Sokoto-Rima basin is used excessively for their own purposes, the contributory role in terms of inflow into the Kainji Lake may be low resulting in dependence on the Black Flood from the Republic of Niger and Mali. With immenent construction of the Kandanji Dam proposed by the Republic of Niger and also anticipated use of the Niger water by upstream countries of the Niger Basin Commission, the continued operations of both hydro may be jeopardized at least in the foreseeable future. In addition, there is a particular problem on the invasion of water hyacinth which may threaten the hydro turbines and increase the reservoir evaporation rate to a high extent.

(2) Inland Navigation

Nigeria has over 3×10^3 km of the navigable waterways made up of the Niger and Benue river systems, the Niger delta creeks and the intercoastal waterways and lagoons. The FIWD as established in 1956 had in the past provided the main communication routes and access from the coast to the hinterland where expatriate traders made an extensive use of these waterways to transport the agricultural products. During those early days and up to the early 1960s, the river transport was very prominent accounting for over 30 percent of the product transport in the country.

The civil war (1967 to 70), however, caused a complete change in the nature and direction of river traffic in Nigeria due to the changes in marketing system and lower agricultural production which have impeded the resumption of this transport mode. As a matter of fact, most major population centres are not located along the Niger or Benue river, and at this stage, the country can be served more cost-effectively by the road transport from existing port facilities at Lagos, Port Harcourt and Calabar.

The flow patterns and conditions along the major rivers have recently been deteriorated due to more eroded sediments from their watersheds and also reduction of the river flows by upstream abstraction. In order to improve these adverse situations, significant modification inclusive of the capital and maintenance dredging scheme is principally required; however, the lack of fund to meet the huge cost and also of technical capacity for these difficult tasks has hampered the implementation of potential development works.

It appears that existing flow conditions over the Niger delta and coastal zone are adequate to support the local passenger and commercial traffic. There is also the perennial problems of water hyacinth along the coastal water which has invaded the FIWD waterways. It is reported that the tremendous progress has been made by the FGN to control the water hyacinth problem with the provision of erected barriers at selected locations to control the spread of weeds, and the FIWD has a plan to procure more weed clearing machines for smooth operations of the current inland navigation scheme.

From the historical point of view, the FGN has entrusted the FIWD with the responsibility of conservancy for major rivers such as the Niger and the Benue including the maintenance and improvement of river channels and the hydrological monitoring being apart from the navigational control. With the promulgation of the Water Resources Decree, No.101 of 1993 on 23 August 1993, a considerable part of the FIWD responsibilities would be transferred to the FMWRRD together with proper adjustment on the contradiction between the Navigable Waterways Decree, No.56 of 1988.

(3) Inland Fisheries

The importance of fisheries sector in the Nigerian economy would be recognized from various perspectives, one of which is its contribution to the balanced diet of population. While an exact level of fish consumption is not available, there is an evidence that the per capita annual consumption of fish was 15 kg in 1981 before dropping to the low level of 4 kg in 1985 which is lower than the African average of 9.3 kg and the minimum requirement of 11.5 kg as recommended by FAO. Data on fish availability and supply sources show an increasing contribution from fish import in the form of frozen whole fish and processed fish while the domestic production has proportionately decreased.

Available data explain that the Nigeria's potential marine and freshwater fishery resources at the maximum sustainable yield can only provide 1.2×10^6 ton against the current national demand of fish which stands at 1.5×10^6 ton. The current fish production at 0.3×10^6 ton consisting of 61 percent from coastal and brackish, 32 percent from lakes and rivers and 7 percent from aquaculture is grossly inadequate. It appears that the desire for self-sufficiency in fish production may only be realized through development of the aquaculture.

Aquaculture development in Nigeria was started in 1951, and the Federal and State agencies have embarked the idea of fish farm production resulting in the operations of some 2,000 rural ponds mostly by small-scale farms. It is reported that the quality of aquaculture system both in extensive and expensive mode is inadequate, and very little or no attention is paid to such practices as water level, fertility, stocking, feeding and so forth. While the total area under aquaculture is still small, the resource potentials are considerable with vast water areas. It has been revealed that there are more than 5.6×10^6 ha of the land available for aquaculture practices throughout the country, and

assuming that only 25 percent are developed, a total output will be 2.8×10^6 ton that will meet more than the projected fish demand in the year 2005.

Nigeria is generally endowed with very large bodies of the natural water as contained in the wetlands, rivers and lakes. In recent years, the FGN has, through the Water Resources Sector, established a large number of the man-made reservoirs. It has been observed that in the effort towards the water resources development nationwide, the FGN has virtually paid little or no attention at all to the important living aquatic resources. To date, many of the large and medium rivers have been dammed up without regard to such resources both up- and downstream. Virtually, there is no fish ladders at the existing hydraulic structures across the rivers, and there has been no pre-impoundment study to protect the ecology of a newly inundated reservoir bottom.

2.3 Regional Constraints and Potentials

2.3.1 General

The previous Sub-Chapter 2.2 "Components of the Water Resources Sector" has examined the present situation and related problems of each service component involved in this NWRMP. This Sub-Chapter translates such findings as pointed out for each service component into the basinwide problems and constraints in the current water resources management. First of all, some of the important indicators on water use and balance for each of surface and groundwater resources are summarized below:

(Unit: 10^6 cu.m)

	NW HA-I	NE HAVIII	CW HA-II	CE HA-III/V	SW HA-VI	SE HA-V/VII	Total
1. Surface water							
(1) Potential	22,400	8,200	32,600	83,000	35,400	85,700	267,300
(2) Water Demand	470	1,200	360	210	280	190	2,710
Public Irrigation	80	260	140	150	40	110	780
Private Irrigation	320	880	70	20	-	20	1,310
Public Water Supply	70	60	150	40	240	60	620
(3) Water Use Rate, (2)/(1) (%)	2.1	14.6	1.1	0.3	0.8	0.2	1.0
2. Groundwater							
(1) Potential	4,340	5,580	8,180	11,380	9,020	13,430	51,930
(2) Water Demand	20	60	20	10	80	70	260
Public Irrigation	-	-	-	-	-	-	-
Public Water Supply	20	60	20	10	80	70	260
(3) Water Use Rate, (2)/(1) (%)	0.5	1.1	0.2	0.1	0.9	0.5	0.5

The JICA Team has understood that there would be the most severe problems on water resources management in the Lake Chad Basin (Northeast Region or HA-VIII) where the advanced water resources undertakings have taken place in Nigeria. Therefore, the most careful and judicious considerations have been given to this problem Basin.

2.3.2 Lake Chad Basin (HA-VIII)

(1) General Overview

This Basin extends over the Sahel and Sudan Savannah zones and is broadly divided into two: (1) the Hadejia / Jama'are-Komadugu / Yobe sub-basin and (2) the Yedseram-Chad sub-basin, both discharging into the fresh water Lake Chad. There would be presently many problems and several constraints for adequate water resources management due to the recent downward trend of Basin rainfall under severe Sahelian drought and also to the alarming prospect of drying up of the Lake Chad.

In view of the inherent geological structure and less rainfall availability prevailing in this Basin, the surface runoff yield in the upper Hadejia / Jama'are is rather high and, when going to the downstream where a large alluvial plain is developed, such runoff is diminishing by evaporation and infiltration at a higher rate; to this end, there is almost close to zero

runoff along the river courses in the middle and eastern part of this Basin even during the wet season. This situation is evaluated below:

		Hadejia at Wudil	Jama'are at Bunga	Hadejia at Gusau	Yobe at Damasak
Drainage Area	(km^2)	16,400	8,000	55,700	82,600
Annual Runoff	(10^6m^3)	1,640	1,270	810	540
Specific Yield	(mm)	100	160	15	7

In the middle part of this Basin, there are the Hadejia-Yobe wetlands which are composed of swamp, grassland and woodland created by the passage of the Hadejia and Jama'are Rivers. The area floods annually to an extent determined by river discharge, and this has supported the diverse socio-economic activities for a long time. However, the construction of Tiga and Challawa Gorge Dams has restricted the extent of flooding and groundwater recharge for these wetlands, and this fact remains that the water management over these wetlands has become an increasingly complex, technical, economic and political issues. The IUCN-funded Hadejia-Nguru Wetland Conservation Project as initiated in 1985 is taking a central role in encouraging the open debate on the present and future water management issues that are critical to the effective conservation of existing biodiversity.

In may be noted that the runoff of the Yobe River at Gashua downstream of the Hadejia-Nguru wetlands is a focus of an intense interest within its downstream area. There is an agreement between the former States of Kano and Borno whereby the former would guarantee an annual runoff of $1,350 \times 10^6$ cu.m at Gashua that is equivalent to the long-term mean for the period of 1964-73; however, its present situation has dropped to 814×10^6 cu.m or 60 percent as evaluated by the JICA Team. At Gashua, there is the headquarters of the EC-assisted North East Arid Zone Development Program (NEAZDP) which is assisting the rural population covering the northern part of Yobe and Borno States to improve their standards of living by the proper use and management of natural resources. The nerve of NEAZDP is the Komadugu-Yobe river system where a study is being conducted with a concept that the efficient and equitable management of this river system is a necessary condition for sustainable development in this area.

The basic water resources in the Borno State is the groundwater held in fairly large quantities in the Chad Formation. Evidence of the surface water is not common, and most of few rivers (Yedseram and Ngadda) that drain the southern part of the State receive rainfall (around 500 mm) for a period of June to September and are discharged into the Lake in an intermittent manner. The water demand in the State has been on the increase in the agricultural and other socio-economic sectors in line with a steady pressure on the desertification and also a population increases. This trend in sectoral competition for the water demand increase will require an efficient management technique of the scarce water resources if the socio-economic development is not to be hindered. In addition, a particular attention should be paid to some of the public irrigation schemes including South Chad Irrigation Project which have been supported by the Lake Chad; however, due to the current critical situation of the Lake Chad, reassessment of these projects is required to harmonize better lake level, water quality, economic returns and environmental benefits.

The repeated droughts of the 1970s and 1980s have led to the drastic changes in the environmental conditions of the Lake Chad; as a result of this drought, the lake area fell to never reached levels corresponding to 1.5×10^3 sq.km instead of 25×10^3 sq.km in normal periods. In 1964, four nations-Nigeria, Cameroon, Chad and Niger that share the lake water and the Lake Chad Basin organized the Lake Chad Basin Commission (LCBC) to ensure the most efficient use of the basin's natural resources and coordinate the development activities. In June 1992, the LCBC with the assistance and cooperation of UNEP, UNSO and FAO presented a master plan for the development and environmentally sound management of the natural resources of the Lake Chad conventional basin.

The Master Plan for the Lake Chad Basin recommends, with a concept that the water resources management poses the major challenge to successful natural resource management, the following:

- To investigate the possibilities of water resources augmentation by such inter-basin water transfer as the Upper Ubangi-Chari Scheme within the context of a much larger proposed TRANSAQUA.
- To improve the water use efficiency.

- To refocus the irrigated agriculture towards food security preparedness and the water development and management on small-scale irritation schemes.
- To reassess the water priorities taking into account the water needs of flood plain areas.
- To reevaluate existing and partially completed water resources works for downstream economic and ecological impacts.

The recommended action plan includes 36 projects for implementation of the Master Plan; however, any product from theses projects has not reached the Study Team for consideration. It is expected that the findings to be obtained through implementation of this Master Plan be incorporated for subsequent updating and improvement of this NWRMP.

In conclusion, reference is made to the climatic instability commonly called "Sahelian Drought" over the Lake Chad Basin where water is the most critical resources. Although the 1950s and 1960s were remarkably wet, the rainfall from the mid-1960s on decreased haltingly over much of the Basin. While the decline led to the great drought of 1972-74, moderate rains returned in the late 1970s, but then the drought resumed reaching its dreadful climax in 1984. Why does rainfall sometimes fail ? Unfortunately, there is no clear answer. Among the possible causes are widespread tropospheric subsidence, an absence of rain-generating disturbances, complex atmosphere-ocean interactions, but on the whole there is still too much surmising on this subject and too little concrete knowledge.

(2) Constraints and Potentials

(a) Defects in Water Resources Development in the Upper Hadejia Basin

Large-scale water abstraction schemes in the Upper Hadejia Basin were based upon international advice in the 1960s due to the need of expanding irrigated agriculture at rapid population growth rate. To date, 14 large and medium-scale dams have been constructed with a total active reservoir capacity of 3×10^9 cu.m which is about twice as much as the inflow. It appears that at present a large proportion of the surface water resources are trapped in these reservoirs, and many of them are always maintained at

a full water level with the fear of less incoming flow resulting in a fact that the reservoir water to be released for downstream is evaporating. This evaporation from 14 reservoirs amounts to 500×10^6 cu.m that is equivalent to about 30 percent of the potential surface water resources. Evaporation loss and available reservoir water in major storages as examined by the JICA Team are introduced below:

		Tiga	Challawa Gorge	Watari	Guzuguzu	Kafin Chiri
(1) Reservoir Inflow	(10^6m^3)	910	460	75	22	35
(2) Active Reservoir Capacity	(10^6m^3)	1,845	900	92	21.5	35
(3) Max. Reservoir Area	(km^2)	178	100	19.6	6.4	8.4
(4) Evaporation Loss	(10^6m^3)	270	130	30	9	12
(5) Available Water	(10^6m^3)	700	330	20	9	8
Ratio : (4) / (1)	(%)	30	28	40	41	34
Ratio : (5) / (2)	(%)	38	37	22	42	23

This unfavorable way at existing reservoirs would have been caused mainly by the lack of inflow monitorings and proper reservoir operations rules and partly by less water demand for the underdevelopment in downstream public irrigation projects. In addition, less emphasis has been placed upon artificial flooding over the downstream wetlands.

(b) Freezing of the Proposed Kafin Zaki Dam

Particular attention has been paid to a large-scale dam project at Kafin Zaki in the upper reach of the Jama'are River which started its construction in 1991 and currently is being suspended due to financial difficulty. Critical review has been made to the layout and design of this project in terms of the size and function; to this end, a conclusion indicates that the project layout is totally defective. In addition, when the loss of production along the downstream Hadejia-Nguru wetlands is taken into account, this project is not feasible from the national economic point of view; therefore, the Study Team recommends that this project be frozen at least during the NWRMP period.

(c) Careful Consideration on the Hadejia-Yobe Wetlands

First of all, the unfavorable performance of larger public irrigation schemes has been highlighted. Undoubtedly, the most successful would be

the Kano River Irrigation Project, but while the farmers' skills have increased over time, newly perceivable problems of a low rate of return and an increasing level of operating costs due to the poor level of OM over the past ten years may ultimately render a significant portion of the scheme inoperable.

With the implementation of Tiga and Challawa Gorge Dams, the total area flooded over their downstream wetlands has been greatly reduced, while the existence of these dams has led to an overall reduction in the variability in the extent of flooding, and this has significantly reduced the level of risk for the wetland farmers. However, this appears to have had serious impacts on the agricultural production and water-related environment as a whole because the large-scale flooding formerly distributed the available water over the large wetlands and thereby effected the vital shallow-groundwater recharge.

In accordance with the recent progress of appropriate, small-scale and local-level fadama development in a form of the private irrigation scheme as supported by the World Bank and the EC, a focus has been given to the rehabilitation and improvement of Hadejia-Yobe wetlands in view of the immediate local human needs and food security. At present, part of these countermeasures has been taken by the H-J RBDA under the political pressures to release the limited flow from upstream water storages during wheat-growing season. It is highly recommended that in view of a surplus reservoir capacity in the Upper Hadejia Basin, the flooding over the wetlands to be made possible by artificial flood releases from those dams in the wet season should be maintained to make possible the production of rice, dry season agriculture, fish, grazing, wildlife as well as biodiversity and shallow-groundwater recharge in connection with the establishment of an appropriate surface water and shallow-groundwater monitoring system.

(d) Problems in Maiduguri Water Supply

Recently, the Alau Dam with a capacity of 106×10^6 cu.m to serve a public irrigation scheme has been completed in the Ngadda River just upstream of Maiduguri in such manner that almost all of the river runoff is stored. In the Maiduguri urban area, there is a serious problem on lowering of the groundwater table because of indiscriminate withdrawal for water

supply, and the recent Alau construction would have accelerated this problem. While a considerable part of the Alau water is currently being transferred to urban water supply scheme through completion of the new water works, a measure to augment the inflow into Alau storage is being carried out through reduction of the flooding over the Sambissa wetlands just upstream of the storage.

It is said that the Sambissa Game Reserve is a major area for the conservation of elephants, last stronghold of ostrich in Nigeria, and still supports lions, leopards, hyenas, a variety of antelopes and giraffes. Under these circumstances, there is the urgent need to reexamine the operations of Alau water reservoir in terms of the groundwater recharging in its downstream, the suspension of public irrigation project, and the proper conservation of Sambissa wetlands. It may be noted that the Sambissa Wetlands Project has been included as Project 18 of the LCBC's Lake Chad Master Plan to examine an overall operational water management plan for a Hawal-Yedseram water transfer.

(e) Communication Problems between Two RBDAs

Virtually, the Lake Chad Basin or HA-VIII is being managed by two RBDAs (Hadejia-Jama'are and Chad). This arrangement creates the communication problems which militate against the coordination of policies and decisions. For example, the closure of the recently constructed Challawa Gorge Dam in 1992 had far-reaching adverse consequences on agricultural production over the wetlands of Jigawa and Yobe States. It is stressed that the control of existing dams is at present sub-optimal as it is limited by technical capabilities, poor communications between two RBDAs and uncertain consequences due to the lack of reliable hydrological and hydrogeological data to be used for planning and operational purposes.

It is recommended that the FMWRRD should formulate an integrated policy for the HA-VIII which will be implemented by two RBDAs, ADPs, independent organizations and water users in this Basin.

2.3.3 Sokoto-Rima Region (HA-I)

Except for the Niger River coming from the Republic of Niger, this Basin which is composed of the Basement Complex area in its eastern part and the Sedimentary Deposit in other is largely divided into the Sokoto-Rima River (88.3×10^3 sq.km) and many of other tributary rivers along the Niger River (43.0×10^3 sq.km). It has been evaluated that the potential surface water resources in seven major tributaries of the Sokoto-Rima are 7.3×10^9 cu.m and this potential is decreased to be 6.0×10^9 cu.m at the confluence to the Niger because of large wetlands along the Sokoto and Lima, while those of other tributary rivers to the Niger amount to 4.0×10^9 cu.m. The potential Niger water at the international border is estimated at 19.0×10^9 cu.m, and the total potential surface water resources at NEPA Kainji site is evaluated at 22.4×10^9 cu.m. It may be noted that the potential resources of both the surface and groundwater in this Basin in term of their yield would be almost identical with those of the Lake Chad Basin.

To date, many large- and medium-scale dams such as Jibiya in the Gada, Zobe in the Bunshur, Bakolori in the Sokoto, Goronyo in the Rima and Kubli in the Swashi have been completed. With the exception of Goronyo Dam, it seems that all of these dams would have a well-designed reservoir capacity in terms of the potential inflow, while their large reservoir surface areas are bringing considerable loss by evaporation and then decreasing the amount of available water for downstream use:

		Jibiya	Zobe	Bakolori	Goronyo	Kubli
(1) Reservoir Inflow	(10^6m^3)	260	240	760	660	160
(2) Active Reservoir Capacity	(10^6m^3)	121	170	403	933	62
(3) Max. Surface Area	(km^2)	26	45	80	200	9.4
(4) Evaporation Loss	(10^6m^3)	36.4	63	96	280	9.4
(5) Available Water	(10^6m^3)	67	104	326	344	47
Ratio : (4) / (1)	(%)	14	26	13	42	6
Ratio : (5) / (2)	(%)	55	61	81	37	76

These dams have the wetlands in their downstream and currently have more or less water disputes on unfavorable flooding issues over the wetlands due to their water storage and subsequent insufficient operations of compensational release. In particular, the Goronyo Dam would face a

serious problem when its upstream water storages are fully utilized, and the inflow into Goronyo storage is substantially reduced. In addition, there are large wetlands developed up to the confluence with the Niger where a large amount of the surface and groundwater is currently withdrawn for domestic water supply to Sokoto urban and surrounding area and agricultural purpose.

At this stage, all of the above-mentioned water storages are in an immature position for downstream water use. There is, therefore, the urgent need to establish appropriate rule of reservoir operations for each dam taking into account an integrated basinwide water management for a series of the existing reservoirs as well as the degree of output decrease at the NEPA-managed A Kainji and Jebba hydro sites, in line with the provision of adequate surface water and shallow-groundwater monitoring system.

As far as the domestic water supply is concerned, the water demand in and around the Sokoto area is rapidly increasing, and there is a recent trend of overdrafting the groundwater resources. It is suggested that the groundwater monitoring be strengthened in association with the establishment of rational reservoir operations rule for Goronyo Dam and the adequate countermeasures for proper OM of many surface water supply works so far provided.

2.3.4 Niger Region (HA-II)

This Region with a total drainage area of 158.1×10^3 sq.km is largely divided into two: (1) the left side of the Niger (120.1×10^3 sq.km) and (2) its right side (38.0×10^3 sq.km). The Niger left has large tributary rivers such as the Kaduna and the Gurara originated form the Jos Plateau and other major tributaries of the Kontagora and the Gbako, while the Niger right has major tributaries of the Moshi, the Oshun, the Awun, the Ove and the Kampe which are rather small in drainage size. With the annual rainfall of 1,000 to 1,500 mm and the Basement Complex area of 77 percent over this Region, the potential surface water resources have been evaluated at 32.6×10^9 cu.m or 206 mm which is considerably higher than those of the North Region (IIAs-I and -VIII). Major tributaries in this Region have the following dimensions:

		Kaduna	Gurara	Kontagora	Gbako	Oshun & Ove	Kampe
Drainage Area	(km^2)	63,700	17,080	8,970	12,120	10,800	12,310
Annual Runoff	(10^6 cu.m)	13,800	8,200	1,080	2,670	1,940	2,710
Specific Runoff Yield	(mm)	217	480	120	220	180	220

On the hand, the total groundwater potential of 8.18×10^6 cu.m or 52 mm is not so high because the Sedimentary Deposit area is located only along the Niger.

Apart from major hydro at Jebba and Shiroro, there are 12 existing dams mainly for irrigation which are composed of the large-scale Kontagora and Omi under construction with a total active capacity of 420×10^6 cu.m and also of 12 medium- and small-scales completed with a combined capacity of 70×10^6 cu.m. In addition, 18 dams for urban water supply to major cities of Abuja, Kaduna, Zaria, Mina, Ilorin, etc. with a total active capacity of 440×10^6 cu.m have been constructed to date, and this is equivalent to about 50 percent of a total active reservoir capacity for water supply purpose throughout the country. Review by the JICA Team has indicated that the reservoir planning for these dams is generally adequate without any problem as examined in the North Region, but some of the small-scale reservoirs are facing the disadvantage of much sediment deposits. Major indicators of main dams for water supply are outlined below :

		Asa	Kagara	Zaria	Kangimi	Suleja	Usuman
(1) Reservoir Inflow	(10^6 cu.m)	184	40	450	1,800	42	260
(2) Active Reservoir Capacity	(10^6cu.m)	34	38	30	59	49	100
(3) Max. Surface Area	(km^2)	?	5.8	8.0	6.6	7.4	8.0
(4) Evaporation Loss	(10^6cu.m)	7	7	9	7	7	8
(5) Available Water	(10^6cu.m)	24	23	21	52	32	100
Ratio : (4) / (1)	(%)	4	18	2	0	17	3
Ratio : (5) / (2)	(%)	71	61	70	88	65	100

Taking into account the present situation as mentioned above, there would be a large potential of expanding the irrigated agriculture in this Region in terms of the surface water resources and available land resources. Because of a large share of the Basement Complex area, careful

consideration of the groundwater withdrawal would be required for rural water supply, while a future trend of providing the water sources for water supply as a whole may be directed to the surface water abstraction by means of the medium- and small-sized multipurpose dam projects.

2. 3. 5 Benue Region (HAs-III and -IV)

The Region is occupied by the Benue River from the international border of Cameroon (drainage area: 98.0×10^3 sq.km) to Lokoja at the confluence to the Niger River (drainage area: 338.2×10^3 sq.km). It has been evaluated that the surface water potential is 83.0×10^9 cu.m at Lokoja, while that from Cameroon and of Upper Benue (HA-III) and Lower Benue (HA-IV) is 13.0×10^9 cu.m, 50.0×10^9 cu.m and 27.8×10^9 cu.m respectively taking into account the water loss of 7.8×10^9 cu.m during the Benue conveyance. Runoff situation of major tributaries is summarized below:

		Gongola	Taraba	Donga	Katsina-Ala	Ankwe	Mada
Drainage Area	(km^2)	53,800	22,400	21,200	22,800	11,600	8,700
Annual Runoff	(10^6 cu.m)	5,500	12,000	19,400	23,000	1,390	1,040
Specific Runoff Yield	(mm)	102	535	915	1,000	120	120

On the other hand, the groundwater potential has been estimated at 11.38×10^6 cu.m taking into account less potential over the Basement Complex area (54 percent) and Upper Benue Sedimentary area (mainly composed of consolidated sandstone and shale) as well as more potential over the Lower Benue alluvial plains.

Generally speaking, the water resources in this Basin have been still underdeveloped with the least population density of 66 per sq.km among others from the socio-political point of view. To date, 11 reservoirs for irrigation have been constructed, in which two major storages at Dadin Kowa (1.77×10^9 cu.m) and Kiri (325×10^6 cu.m) along the Gongola are specified while others belong to the medium- and small-scale ones with less than 15×10^6 cu.m each. Virtually, there is no dam on the left side of the Benue River mainly originated from the Cameroon border. For domestic water supply, 21 reservoirs with a total capacity of 140×10^6 cu.m have been

provided in and around Jos in the Plateau State. As far as the groundwater is concerned, its development level with a withdrawal rate of 0.2 percent is lowest in Nigeria particularly over the left side of the Benue which is covered by the Basement Complex.

Critical review on the function of the Dadin Kowa Dam as completed in 1988 has been made. The original plan indicates the development of 34 MW power and 38×10^3 ha irrigation; however, there is no potential of the land suitable for irrigation along its downstream course with the exception of 4×10^3 ha on the right side upland, and the hydro facilities have not yet been equipped. In view of obtaining quick return for the huge investment made by 1988 and two advantages of most favorable inflow conditions (2.5×10^9 cu.m) and its downstream Kiri Dam as a regulating reservoir, a necessary action to change the main objective of Dadin Kowa Project to the peak hydropower should be sought. It is also stressed that since the Benue left basin is blessed with higher runoff rates and fertile land along rivers suitable for irrigated agriculture, more attention should be paid by the Government to the provision of medium- and small-scale multipurpose dams including rural water supply and mini-hydro for isolated local demand to enhance the rural activities for currently most depressed area throughout the country.

2.3.6 Western Littoral Region (HA-VI)

This Region with a drainage area of 100.5×10^3 sq.km is bound by a low watershed on the right side of the Niger River where 9 major rivers are flowing southward into the Gulf of Guinea. The surface water potential has been identified at 35.4×10^9 cu.m or 352 mm, a high specific runoff yield of which is next to that of the Eastern Littoral Region. The annual runoff situation of major rivers is given below:

		Ogun & Oyan	Ondo	Oshun	Owena	Osse	Ossiomo
Drainage Area	(km^2)	22,060	5,640	10,130	10,900	13,730	10,300
Annual Runoff	(10^6 cu.m)	6,620	2,260	4,050	4,360	4,810	4,120
Specific Runoff Yield	(mm per year)	300	400	400	400	350	400

From the hydrogeological point of view, the northern part of this Region is composed of the Basement Complex area (60 percent) while the southern by the Sedimentary area, and the regional groundwater potential has been estimated at 9.02×10^6 cu.m. To date, the groundwater withdrawal has been positively carried out by local industries and partly by public water supply at a current rate of 0.9 percent that is the second highest in six Regions. Water quality is generally good although iron occurs at depth while the local salinity problems are seen at Lagos area where overpumping has invited the intrusion of sea water into coastal sand aquifers.

To date, 11 dams mainly for irrigation and 21 dams mainly for domestic water supply have been constructed with a combined active reservoir capacity of $1,050 \times 10^6$ cu.m. Dimensions of major dams are summarized below:

		Ikere Gorge	Oyan	Elinle	Asejire	Egbe
Reservoir Inflow	(10^6 cu.m)	1,020	2,250	360	1,860	670
Active Reservoir Capacity	(10^6 cu.m)	565	254	75	31	20
Reservoir Area	(km^2)	53	40	16	5.3	?

Other than the above are categorized into medium- and small-scale storages with less than 10×10^6 cu.m each, and also there are many diversion dams for small domestic water supply. Major multipurpose dams at Ikere Gorge and Oyan under the O-ORBDA have been already completed for irrigation, water supply and hydro; however, the arrangement to use the stored water has been in slow progress, and part of it is applied to only domestic water supply. Other dams at Elinle, Asejire and Egbe are operated for only water supply purpose. It is general that all the reservoirs are full of water at the end of wet season and operated without any carry-over capacity, resulting in a higher turnover rate.

In spite of the rather favorable seasonal distribution of higher rainfall, the supplementary irrigation is required for this Region particularly in its northern part. In general, the irrigation development has the characteristics that are cheaper to construct and generate high return; however, more effort should be made of the factors essential for the success such as the farmer's involvement in management and OM in terms of their ownership of infrastructure for the issues of tenure security.

2.3.7 Eastern Littoral Region (HAs-V and -VII)

This Region comprises the HA-V of 53.9×10^3 sq.km occupying the Niger River and Delta downstream of Lokoja and the HA-Ⅶ of 73.2×10^3 sq.km including the south-eastern corner of Nigeria. The Cross River in the HA-Ⅶ originates in the Cameroon Highlands of Cameroon where the annual rainfall may exceed 4,000 mm and the dense rain forest is prevailing, and more than 20×10^9 cu.m is discharged into Nigeria. The hydrogeological structure in this Region is organized by the Sedimentary Deposit area (86 percent) and the Basement Complex area that is distributed along the eastern periphery. Because of the most favorable situation on rainfall throughout Nigeria, the potential water resources are highest being evaluated at 85.7×10^9 cu.m or 674 mm for surface water and at 13.43×10^6 cu.m or 118 mm for groundwater.

Since there is still an imbalanced distribution of the annual rainfall between the wet and dry seasons, 18 dams for irrigation and water supply have been constructed along the small tributaries with their main function as the run-of-the-river diversion; however, the water shortage problems in some of the projects occur due to much irregular pattern of the dry season runoff. On the other hand, the groundwater withdrawal rate (0.5 percent) for domestic water supply is rather high particularly for the urban use although its service level, however is in the lowest position throughout the country. A large part of the Enugu and Anambra States and the Cross River upper basin is undulated in topography, and major parts of the urban and rural areas are scattered on the top of hills; therefore, the water supply by abstracting groundwater would be expensive, and this should be examined in comparison with a possible surface water scheme. It is also noted in this Region that every effort be made for the quick restoration of man-made gullying disaster and the proper erosion protection measures, as are explained in para. 2.2.4.

2.4 ENVIRONMENTAL CONSIDERATIONS

2.4.1 General

Sustainable development is defined as projects and policies which promote per capita economic growth without jeopardizing the integrity of the physical stock of renewable and environmental resources; thus, the

environmental degradation hampers, to a large extent, the achievement of sustainable development and / or reduces the level of sustainable development possible. The most complex and overriding causes of serious environmental degradation in Nigeria are poor management and the lack of information on quantity and quality of the resources, resulting in unsound decisions regarding the use and renewal of resources. As a matter of fact, many water resources development activities reflect the tenet that "one action causes many types of problems" in the environmental resources sector.

The overall scope of environmental concerns throughout the country is significant, but the discussion in the NWRMP Study has been limited to those areas of environmental concerns that most directly affect and are affected by the water resources planning and development. While the FGN listed a total of 14 major sectors and problem areas of the environment, two areas such as (1) water resources management and (2) land use and soil conservation are directly involved, while several other areas of concern indirectly influence the approach to water resources planning but are difficult to address in the NWRMP Study because those factors require long-term solutions at all levels of the Nigerian societies.

2. 4. 2 Environmental Problems in the Water Resources Sector

In the NWRMP Study, seven items have been identified:

(1) Drought and Desertification

Principal causes of desertification which represents the extreme degradation of soils as a result of many interacting factors include (1) lowered water tables resulting from groundwater overdraft and unfavorable surface water management, (2) removal of vegetative cover, (3) overgrazing, and (4) uncontrolled bushburning. Once the trend of soil degradation and productivity loss begins, the combination of cause and effect results in a spread of the condition to adjacent areas. Groundwater table continues to fall, infiltration decreases, and runoff and erosion increase.

(2) Reduced Availability of Flow in Downstream Area of Rivers

There are many cases of the priority to upstream users with the water disputes on equitable distribution among the water needs upstream and downstream. With the progress of upstream diversion, typical examples are seen in Nigeria for the power output decrease at Kainji and Jebba, the shortage of flooding along the Hadejia-Yobe wetlands in the Lake Chad Basin, and the seawater intrusion in the Niger Delta. An integrated policy of the water use and water-related environment throughout a basin should be properly established.

(3) Watershed Management

As with most problems involving the environmental degradation, different manifestations of related deterioration are not distinct but inter-related resulting from common causes. Several categories of the watershed management problems fall into this pattern; these include soil degradation, deforestation, soil erosion, wildlife and fisheries losses and local flooding.

(4) Water Pollution, Water Hyacinth and Eutrophication

Adequate water availability is obviated when the available supplies cannot be used for the required purposes. The resulting lack of quality water would create shortages in potable water supply, health problems for consumers, increased costs for water treatment, losses of wildlife and reduced crop yields. Virtually, Nigeria has no national water quality standards and no national water quality monitoring agency. The causes of water quality degradation include (1) uncontrolled or untreated discharges from waste handlings, (2) unwise land use practices, (3) improper practices in applying the agricultural chemicals and (4) proliferation of aquatic weeds.

(5) Water-Related Diseases

Tropical climates have historically been subjected to a wide variety of disease organisms and vectors, and the exposure cycle for many of these diseases revolves around water generally found in abundance in tropical areas. The occurrence of this wide variety of diseases in Nigeria is not unexpected;

however, recent evidence indicates that an unwanted side effect of some types of the water projects is an increase in some disease rates.

Limited studies have demonstrated the evidence of increased water-related disease rates following the implementation of water projects. The water-related diseases are generally classified into four main types: (1) water-borne, (2) water-based, (3) water-related, and (4) water-washed. In addition to these diseases which are essentially communicable or infective diseases, the water resources development projects can also have other environmental impacts such as (1) contamination by agro-chemicals, (2) increase in salinity and (3) rise in water table resulting in water logging.

(6) Socio-Economic Impacts

The most important socio-economic issues dealing with the water resources projects are resettlement problems. Related concerns include the creation of slum areas used by workers and merchants having no sanitation facilities and the improper final treatment of sites after use leading to land degradation and erosion.

(7) Lack of EIA for Water-Related Projects

It is common that the water resources projects may initiate or exacerbate the environmental degradation and loss of environmental resources. In Nigeria, a little coordinated statutory or enforcement structure has existed to safeguard the environment, and the water resources projects have historically been implemented with no focus on environmental problems. In addition, there has been the lack of coordination between responsible Ministries for the projects that affect wide sectors of the economy and populace.

Comparative severity of the environmental problems in each of six Regions has been addressed for future reference, as shown below. The level of environmental problems points to the need for the coordinated management of environmental resources, including careful determination of the potential effects of water resources projects in the areas already suffering environmental degradation.

Environmental Problem	NW HA-I	NE HA-VIII	CW HA-II	CE HA-III/IV	SW HA-VI	SE HA-V/VII
Drought/Desertification	3	3	2	1	1	1
Watershed Management						
Soil degradation	3	3	2	1	1	2
Deforestation	3	3	3	1	3	3
Soil erosion	1	1	1	1	2	3
Coastal erosion	1	1	1	1	3	3
Wildlife/Fishery losses	2	2	2	1	3	3
Flooding	2	2	2	2	3	3
Reduced Water Availability Downstream	3	3	2	1	1	1
Water Pollution	1	2	2	1	3	3
Water Hyacinth/Eutrophication	1	2	2	1	3	2
Water-Related Disease	2	3	3	2	3	3
Socio-Economic Impact	3	3	3	1	1	1

Key: 3 = severe; 2 = moderate; 1 = minor

2.4.3 Environmental Problems Associated with Water Resources Projects

The JICA-NWRIS intended to compile the general environmental situations and problems related to the Water Resources Sector; however, little specific information was available. The primary reasons for this include:

- this type of information has historically not been a priority for monitoring and collection.
- few, if any, coordinated data collection programs exist in the several Ministries dealing with water-related problems.
- unreliable recording and record-keeping prevents widespread use of existing information.

There have been a number of notable cases of the adverse environmental impacts particularly water-related diseases resulting from the water resources development projects. In recognition of these problems, the JICA Team has recognized that due emphasis need be given to the major water resources-related environmental problems, and the need to combine the environmentally-sound management approaches with sustainable development. Environmental problems and impacts associated with drinking water supply, river basin development, reservoir development and dam construction are indicated as the major areas of concern and have been briefly compiled as follows:

Environmental Parameter	Dams and Reservoirs	Irrigation	Inland Water/ Coastal Zone	Water Supply	Drainage/ Sewerage
Surface Water Hydrology	3	1	2	3	3
Surface Water Quality	2	3	3	2	2
Groundwater Hydrology	2	2	2	1	1
Air Quality	1	1	2	2	2
Erosion/Sedimentation	3	2	2	2	2
Thermal Stratification	3	1	1	1	1
Geology/Seismicity	3	1	1	1	1
Drainage and Salinity	3	3	1	1	1
Soil Fertility	2	2	1	1	1
Fisheries	3	3	3	3	2
Terrestrial Wildlife	2	1	2	2	1
Forests	2	1	3	2	1
Navigation	2	1	2	1	1
Land Use	3	3	1	1	1
Nutrition	3	3	1	1	1
Flood Control	2	1	1	3	3
Highways/Railways	2	1	1	1	1
Archaeological Significance	2	1	1	1	1
Resettlement	3	1	1	1	1
Aesthetics	2	1	1	1	1
Public Health	3	3	2	1	1
Socio-economic Impact	3	3	3	2	2

Key: 3 = severe; 2 = moderate; 1 = minor or negligible

CHAPTER 3. NATIONAL WATER RESOURCES MASTER PLAN (NWRMP)

3.1 GENERAL PRINCIPLES AND STRATEGIES

3.1.1 General Principles

A scenario of the National Water Resources Master Plan (NWRMP) towards the year 2020 has been prepared on the basis of water availability and current problems and constraints which are summarized in the previous Chapters as well as of the Government goals as are provisionally described in "A Pre-Plan Vision Document Towards A Perspective Development Plan for the Federal Republic of Nigeria" (by the year 2010) which has been circulated to various Government agencies by the National Planning Commission (NPC) in December 1992.

A framework of the National Perspective Plan calls for the undertaking of new initiative in quest by all levels of the Nigerian societies to ensure the overall well-being of the people through sustained improvement in their living standards. The overriding objective of the Plan that is well-interpreted as a Human-Centred Development Plan requires a renewed commitment to developing the country's human resources through investment in health, education, nutrition and food security, job creation and other social services, with a particular emphasis upon the improvement in decision-making capability at the grass roots level. In order to build on the gains from previous Development Plans and the on-going SAP over the Plan period, the country would need to embank on a process of real adjustment requiring the reorientation in focus and policy from dependency to self-reliance as opposed to autarchic self-sufficiency. Aside from several broad and specific objectives given to the Human-Centred Development Plan, the Plan presents the general principles and broad outlines of feasible sectoral plan strategy and its implications for the selection of particular project and program options among other alternatives, with a focus not only on purely long-term economic prospects but also on the ancillary factors of demographical and socio-political conditions. The sectoral development strategies incorporated into the Plan include:

- Agricultural Development Strategy

  There is the need for reinvigorating production in agriculture for food security purpose and domestic sourcing of raw materials in manufacturing and also for removing the imbalance resulting from undue focus on urban development at the expense of rural neglect. Two propositions underpin this Strategy:

  - Smallholder private production effectively backed by market-oriented agricultural policies.
  - Agriculture-cum-informal sector-centred development strategy.

- Infrastructure Development Strategy

  While existing water supply, irrigation, electricity and other public services are of poor quality with low capacity utilization, the infrastructure development is an essential pre-requisite for facilitating future growth process. First of all, the Plan emphasizes a concept of the Balancing Modernization and Rehabilitation (BMR) of existing infrastructural facilities. Since it is necessary to bring the informal sector most dynamic in the national economy to the central stage of development process, a particular approach should be taken as the Rural Oriented Small-Holder (ROSH) Development Strategy with an attempt to upgrade the institutions that serve the informal sector and also to focus on small to medium enterprises particularly being complementary to agricultural development.

- Other Strategies, including those of Industrial Development, Manpower Development (education and health) and Balance of Payment which would be complementary to the water resources policy.

3. 1. 2 Specific Strategies

Four specific strategies have been incorporated into the preparation of the NWRMP towards the year 2020 in line with the general principles as stated in para. 3.1.1 in general and the promotion of strengthening institutional arrangements including partial commercialization program for the RBDAs in particular:

(1) Improving Water Resources Management

The weakness as outline in Chapter 2 requires a renewed approach on improving the management of water resources based upon the sound policies and strengthened institutional arrangements. This approach has two guiding principles:

- The policies and activities in water resources management should be formulated within the context of a comprehensive analytical framework which takes the inter-dependencies among the sectors concerned into account and protects the ecosystems. This framework may lead towards the establishment of improved coordination among institutions, consistent regulations, coherent policies and targeted Government actions.
- The efficiency in water resources management should be improved through the greater use of pricing and through the great reliance on decentralization, users participation, privatisation and financial autonomy to enhance the accountability and improve the performance incentives.

Concurrently, appropriate systems for protecting and restoring the water and environmental resources need to be established. Moreover, the international organizations should play a larger role in helping Nigeria to improve the management of international water resources.

The primary roles of the public institutions in the water resources sector are (1) to define and implement a strategy for managing the water resources; (2) to provide an appropriate legal, regulatory and administrative framework; (3) to guide inter-sectoral allocations; and (4) to develop the water resources in the public territory. This strategy should spell out the priorities for providing water services; establish the policies on water rights, water pricing and cost recovery, public investment and the role of private sector in water development; and institute the measures for environmental protection and restoration.

Investments, policies and regulations in part of a river basin or in one sector affect the activities throughout the basin; therefore, these decisions need to be formulated in the context of a broad strategy which takes the long-term view, incorporates the assumptions of actions and reactions of all participants

in water resources management and fully considers the ecosystems and socio-economic structures that exist in a river basin. Although this is an indicative planning process for dealing with the cross-sectoral and inter-linkage issues, the goal is to ensure the sustainability of water environment for multiple uses as an integral part of the Nigeria's economic development process. While the level of complexity of the strategy may differ among Regions or States depending upon their problems, resources, priorities and capabilities, its execution and management should involve the public sector, private enterprises and water users groups.

Although the comprehensive analytical approach provides a framework for managing the water resources, it does not require a centralized delivery of the services. On the contrary, where the local management capabilities make it feasible, increasing the reliance on decentralized mechanisms changes the nature of the Government's work. It is commonly reiterated that the public finance theory and welfare economics provide an analytical framework for examining the public and private good characteristics of water resources activities as well as other attributes determining the efficiency of market forces. The provision and some of the production of pure public goods are essentially the responsibility of the Government, while pure private goods can be handled efficiently by markets; however, most of the water activities are not strictly public or private goods, and these frequently require some forms of the Government regulation or involvement if the resources are to be used efficiently. Instead of distributing water, the Government should focus on establishing the incentives to ensure that water is distributed in the desired quality and at the lowest possible price that reflects its value taking into account the special needs of the poor.

In Nigeria, the development and management of water resources have been dominated by the Government, because it was believed that only the Government was able to handle the large investments and operations necessary for irrigation and water supply systems and that the crucial role played by water justified the Government control. The fiscal crisis that began in the mid-1980s, however, demonstrated the weakness of much of this argument. It has been observed that the deteriorating irrigation systems and the inadequate water supply infrastructures throughout Nigeria have exposed the serious institutional deficiencies of many Government agencies responsible for water resources. These include the lack of motivation and accountability of

agency staff, high levels of political interference, and inadequate concerns for the needs of users; consequently, the users are not motivated to share in the costs of investments and maintenance or to pay for the services.

Solving these problems requires many inter-related reforms. One approach gaining the support is to increase the use of the private sector through concessionaire contracts, management contracts, private ownership, and participation by the users and communities in managing the water resources. This approach can introduce appropriate incentives which provide a sense of responsibility for water systems, improve the accountability and concern for users needs, constrain the political interference, increase the efficiency, and lower the financial burden on Government. As a matter of fact, the users and private sector participation in water management is not new, viz. the communal irrigation systems have existed for generations in many of the Asian countries, while the development of private wells has been a major source of the irrigation expansion for the past two decades. It is general that the idea has a tendency to be resisted by the vested bureaucratic interests or to be rejected due to the lack of confidence in the capacity and incentives of the private sector; however, the continued decline in the performance of irrigated agriculture and the inadequacy of water supply systems have brought this top-down approach under great scrutiny that are frequently examined in the NCWR meetings.

(2) Enforcement of the Water Resources Decree, No.101 of 1993

The Decree was promulgated on August 23, 1993 with the long period in processing this comprehensive water resources legislation first proposed in 1980 and subsequently refined with the assistance of FAO. This legislation permits the FMWRRD to undertake its mandated responsibility for efficient management of the nation's water resources, more particularly to resolve the issues of competing demands among domestic users, remove inter-state rivalries over water allocations, help resolve international water right issues in the Lake Chad and Niger/Benue basins and to ensure due attention is paid to hydro and inland navigation needs as well as to the watershed management.

As a matter of fact, the Decree composed of 21 Sections is giving the FMWRRD a broad foundation to perform the Federal administration of the water resources management; therefore, a series of the regulations needed for due enforcement of the provisions of this Decree should be established as

quickly as possible ensuring appropriate standards and techniques for management and administration of the rather limited water resources under progressively degraded water-related environment. Urgent attention should be paid to, among others, clear demarcation of the Federal responsibilities; preparation of the river registers; implementation of the hydrological monitoring and surveillance with the establishment of Basic Reference Control Points (BRCPs) over major rivers and Monitoring Wells for critical groundwater withdrawing areas in terms of quantity and quality; initiation and preparation of the proper implementation procedures on irrigation, waterworks, sewerage, multipurpose dams and so on; establishment of the appropriate coordination system and consistent regulations for water resources activities and watershed management programs among the agencies concerned; and the institutional arrangement for enforcing the decree within the FMWRRD.

(3) Proper Operations and Management of Existing and On-Going Water Resources Projects and Facilities

More fundamentally, this should include two important items:

- Full and effective utilization of existing water storages which would be directed to the provision of appropriate reservoir operations rules being inclusive of downstream water demand, the solution of dam safety problems and the addition of associated public irrigation and water supply schemes if surplus is identified.
- Rehabilitation and OM upgrading of existing water utilization schemes for public irrigation and water supply.

The rehabilitation and upgrading of existing and on-going water resources infrastructural facilities should be undertaken with the concept of BMR as called for by the National Perspective Plan in order to harvest with anticipated potential benefits the previous huge investment in which substantial costs have been already sunk. This should be, with the top priority, materialized with possible solutions on inadequate planning, insufficient relevant manpower, haphazard implementation, social issues, environment as well as funding and water rating and cost recovery.

(4) Appropriate Implementation of Water Resources Projects with Priority Given to Medium- and Small-Size

With a view to mobilizing the water resources to ensure the overall well-being of the people through sustained improvement in their living standards throughout the country as called for by the National Perspective Plan, the water resources projects in a medium- and small-scale form should be promoted for implementation in such manner as (1) self-reliance, (2) human-centred approach and (3) focus on household production unit in the informal sector on the basis of the maintenance of environmental protection as well as the improvement for implementing capability of the Government agencies and the strengthening of institutions to facilitate more effective cooperation and greater participation of the local people concerned.

The history of irrigation success in Nigeria has been that smaller-scale and decentralized schemes have been more successful from the cost-benefit standpoint than larger schemes. From an environmental point of view, smaller schemes are less stressful on the environment, able to respond more quickly to changes and needs of the local environment, and are cheaper to initiate and maintain. Promotion of smaller-scale water resources projects may also improve water use efficiency and conservation which benefit the downstream users and habitats.

Keeping these requirements in mind, a series of multipurpose medium- and small-scale water resources projects mainly for irrigation and domestic water supply and partly for mini-hydro and fisheries should be promoted over the tributary basins and systems where the availability of surface water resources is identified. Apart from the North Region, the priority should be shifted to the Middle-Belt Zone or Central Zone for irrigation and to the South Region for water supply as a whole.

3.1.3 Strategic Issues in Project Undertakings

(1) Project Preparation

During the first half course of the NWRMP Study, it had proved extremely troublesome to obtain the reports of previous project studies carried

out for the FMWRRD and RBDAs. Virtually, there is no central library well-established, and the whereabouts of a report and volumes of a report are frequently unknown. And, the thorough inspection of recent project reports by the Study Team suggests that the requirements for project studies particularly in a feasibility study are improperly understood. The general requirements of the feasibility report are that a study team should collect, analyze and present all necessary information to determine the technical feasibility, environmental soundness, economic viability of a proposed project or program. Many of the previous examples were lacking in many aspects and would be deemed to be described in the mode similar to those of a pre-feasibility study which is normally commissioned to identify a project(s) and determine whether the investment in a full-scale feasibility study is warranted. It is strongly recommended that future studies should be carried out upon setting clear guidelines in line with the internationally recognized standards as applied by the World Bank and similar organizations.

The study relevant to the components in the water resources sector has pointed out that much of the existing project undertakings were not properly planned, implemented, operated and in particular maintained with less emphasis upon regular repair works. It is needless to say that the good planning needs sound basic data and next, the effective implementation could result from good design and supervision, fair and disinterested international or domestic competitive bidding, and sound public accountability. Efficient OM should result from training, dedication, motivation, and a proper understanding of the objective and function of the project works, and also the need to generate funds to keep them in a good working order. On the top of these items, the broad people participation is required at all levels and stages of development.

(2) Trade off between Project Preparation and Implementation

The importance of adequate preparatory work has been repeatedly borne out by experience. There is no doubt that better project preparation could reduce the likelihood of implementation problems. In this occasion, a question still remains: how much preparatory work and in detail to what extent. Behind this question lies the recognition that there is, at least beyond a certain point, a trade off between the investment of additional resources in project preparation and the use of those resources to help implement the project.

The terms of trade off can be usefully analyzed in relation with the conditions ranging from "Hard" items such as infrastructure components including civil works and major items of equipment to "Soft" items such as institution building, staff training and the design of mechanisms for users participation. Completing the detailed engineering or design of the "Hard" component before the funds are committed may substantially reduce the risk of construction cost overruns and implementation delays owing to imprecise estimates of the physical works quantity to be executed. On the other, it can be unproductive beyond a point to devote detailed preparation effort to a project "Soft" component, the success of which is largely determined by the behavior patterns about which less can be known in advance. After the project starts, the design of such component may require considerable adaptation to fit various users requirements or a rapidly changing natural and social environment.

Even when there is much that cannot be known in advance, it is essential that the project preparation makes the fullest possible use of the information available. Such preparation should specify clearly the project objective, ensure definitely the commitment of all parties concerned including the proposed users and beneficiaries to those objectives and then positive participation, and outline in detail the required inputs and arrangements with respect to organizations, institutions and procedures. For example, a common shortcoming of the training program when included as a component in projects has been that this has not been adequately prepared in advance, and there are consequent delays, misunderstandings and mistakes during the course of project implementation. As a matter of fact, there may be a point beyond which more elaborate analysis is not justified by the collection of knowledge.

When the important uncertainties exist, sufficient flexibility should be built into the project layout and design so that the elements can be reappraised and the arrangements and procedures modified in the light of practical experience. The need for flexible implementation should be anticipated during the project preparation, and the staff resources should be accordingly budgeted. When the uncertainties with respect to project design in "Soft" term are large, it may be preferable to begin with a small-scale pilot demonstration scheme as a development model that is deliberately experimental in nature and to evaluate its implementation closely.

(3) Planning and Managing the Project Implementation

Needless to say, most work done in the earlier stages of the project cycle such as identification, preparation and appraisal is directed towards ensuring successful implementation. In Nigeria, breaking ground for a new project or signing a loan with an external agency attracts much official and press attention; however, the project implementation has received little attention not only from the supervising Government agencies but also from those directly engaged in the development process. The long, slow process of tackling the myriad of problems that frequently arise during the project implementation is seldom in the limelight unless the things go badly. In the real societies, events seldom go strictly according to the plan; both external circumstances and some of the project principle factors change; and consequently, the project implementation takes on a life of its own.

In a broad sense, the implementation of a project begins when the resources are committed to a particular investment, but an irrigation and drainage project, for example, comprises a variety of associated activities such as construction of main systems, on-farm works, provision of extension and marketing services, credit to farmers, training program, and so forth that are of more or less importance and that begin and end at different times. In Nigeria, planning the implementation of a project virtually tended to be neglected. The emphasis was on the decision-making process without taking adequate account of the capacity of the institutions to execute and operate them. The resulting shortcomings, difficulties, and failures have helped to direct attention to the need to plan explicitly for implementation.

The subject item in this paragraph may take up three main planning and organizational issues: (1) the selection of an implementation unit from among different organizational alternatives along with the related issues of coordination and supervision; (2) the organizational implications of different technologies and types of projects; and (3) techniques for planning and managing implementation being composed of critical path analysis including the most common method of the PERT (Program Evaluation and Review Technique: PERT/time and PERT/cost), monitoring and evaluation, and management information system. The next sub-paragraphs will examine the coordinating mechanisms, and the techniques for managing the project implementation in some detail.

(4) Coordinating Mechanisms

A difficult organizational issue arises in the case of multicomponent projects such as those for irrigation and drainage and of multipurpose projects such as those of dams and water conveyance canals, that have to be implemented by several agencies. Appropriate coordinating mechanism should be established among these agencies, and there are some possibilities, but many experiences have suggested that any coordinating mechanism can be effective only if it satisfies two conditions: (1) a clear definition of the responsibilities for each of the participating agencies, and (2) adequate incentives for each of them to work constructively to achieve the project objectives. There would be three alternatives as given below:

- One solution to the need for coordination should establish a special project until through which funds are channelled from the Federal budget in the Federal Ministry of Finance to the implementing agencies.
- Another is for one implementing agency to take the leading role acting as a project unit to coordinate the activities of other participating agencies and sometimes to allocate funds. In this alternative, a special unit for the irrigation projects and multipurpose dam projects may be provided in the Project Planning and Coordination Divisions of both the Departments of Irrigation and Drainage, and Dams and Reservoir Operations, respectively.
- A third alternative frequently adopted is to appoint some type of coordinating committee which should be given the requisite authority. Each participant should be as close as possible to actual operations. Any committee of ministers or other high-level officials with many other responsibilities have seldom performed well.

(5) Monitoring and Evaluation

Monitoring of the progress of a project focuses primarily on "What" is or is not happening in relation to both inputs and outputs; while Evaluation either during or after project implementation seeks to explain "Why" project outputs, effects and impacts were or were not achieved. A monitoring and evaluation system examines three aspects of a project: (1) its physical progress; (2) project cost; and (3) project benefit. The analysis of information about these

three aspects constitutes a logical sequence of activities; therefore, this system may be considered as a composite group of activities to monitor physical process, cost and benefit; to subsequently evaluate the project; and finally to take whatever action might be needed, corrective or otherwise, as indicated by the evaluation. More strictly;

- Monitoring is defined as the timely gathering of information on project inputs (costs incurred), outputs (physical progress of works), and complementary activities that are crucial to the attainment of the project objectives.
- Evaluation, on the other hand, involves the comparison of effects and impacts of the project against the established plans, and this seek to establish "Why" there are discrepancies between the actual results and targets and draws the policy implications.

The Monitoring can be a relatively straight forward and inexpensive system which provides an early warning to the project management about potential or actual problems, and should be based upon a set of simple indicators that can be collected and processed in time for management to take necessary actions. The Monitoring is, in effect, a streamlined management information system with the design of appropriate indicators. In can also be used to inform the higher officials in the project departments, FMWRRD or the Federal Ministry of Finance of implementation progress and problems.

The Evaluation in this context is an on-going activities, as distinct from "Ex Post Evaluation" which is undertaken when the implementation has been completed and is used for accountability, planning of future projects, and research. The purpose of on-going evaluation is to reassess the project objectives and the means of achieving them in the light of experience and new development as the implementation proceeds. And, this goes hand in hand with the project monitoring, drawing on information supplied through monitoring as well as special duties to reconsider the project objectives and modify them accordingly. The evaluation should be done on a timely basis if it is to serve its purpose - an obvious point, but one that is often missed.

The Monitoring and Evaluation are normal functions of the project management, to be performed and then used directly by it. Generally, a monitoring and evaluation unit is established under the project director and

needs to be well integrated with the rest of the organizational structure for project implementation. It is commonly observed in many other countries that the practice has not necessarily been consistent with the theory. There are many instances in which the monitoring and evaluation systems have made a substantial contribution to the improved project implementation; on the other hand, the monitoring has often become just another data gathering effort, seldom influencing the management's decisions, in other words, large amounts of data were collected but not processed; if processed, they were not used. Several pre-requisities may be suggested for success:

- Project directors should appreciate the project monitoring and evaluation system and be committed to its use.
- Decisions for the data to be collected should be focussed upon the problems that should be solved during the project implementation.
- Requirements for the data collection should be adapted to the realistic standards of accuracy, timeliness and cost.
- The project monitoring and evaluation system should be designed at an early stage of the project preparation, in particular, during the course of a feasibility study, and the baseline data related to "Project Benefit" through a benchmark survey should be collected well in advance.

3.1.4 Output of the Study

The water resources should be managed in the context of a national water strategy that reflects the Nigeria's social, economic and environmental objectives, and is based upon an assessment of the country's water resources. The assessment would include a realistic forecast of the demand for water on the basis of projected population growth and economic development, and the consideration of options for managing demand and supply, taking into account existing investments and those likely to occur in the private sector.

All of the four strategies as identified in para. 3.1.2 to meet the anticipated water demand in various sectors concerned have been properly interpreted as much as possible at a master plan level within the timeframe given to the Study and under the constraints of shortage of relevant data and

information. To this end, appropriate arrangement of implementing the NWRMP has been presented in line with the concept that the items (1), (2) and (3) as described above are categorized into the Action Plan with the target year (2000), while the item (4) which should be prepared for clear pre-arrangement within the Action Plan period is scheduled for its implementation after the year 2000.

The NWRMP thus prepared has delineated a basic framework with its overall objective that is comprehensive, realistic and integrated development and management of the water resources leading to the maximum utilization of all other resources throughout the country. It represents the basic foundation and framework for proper implementation for the period of 25 years from 1996 to 2020 and should be upgraded periodically, for instance, once in every five years to remain abreast of the changing conditions and other impacts that may arise. Overall planning of this nature is as complex as it is imperative. The actions to further the NWRMP are to permeate the entire societies to a level where every individual and facet of the economy may be influenced to some degree. The NWRMP that is the output of the Study should be oriented to have a more direct effect on more people than any other features of the current national planning.

3.2 COMPONENTS OF THE WATER RESOURCES SECTOR

3.2.1 Water Resources Monitoring Program

Monitoring and observation schemes of both the surface and the groundwater resources are the pre-requisite for appropriate enforcement of the Water Resources Decree, No.101 of 1993 as well as proper implementation of the BMR works for existing and on-going projects and of the proposed projects to be included in the NWRMP.

(1) Climate and Surface Water

(a) Rainfall

At present, there are 1,070 rain gages in Nigeria which are observed by the FDMS and other related agencies, of which some are not functional.

Overall rehabilitation together with establishing a proper system for sustained observation should be undertaken for all of these gages. In addition, new rain gages should be provided at the BRCPs over major rivers, at the sites of existing large-scale dams for proper reservoir operations and at the sites which give the representative information over the priority basins where the proposed water resources development is contemplated.

(b) Evaporation

This is currently observed only at 23 gages throughout the country. Since this density is too large to achieve appropriate water planning and operations, due emphasis should be placed upon the provision of Class A pan gages at the sites for rainfall observation as mentioned previously.

(c) Surface Water

There are 358 gages nationwide; however, about 50 percent are functional. In accordance with the proposed water resources development and management involved in the NWRMP, a total number of 434 for surface water discharge monitoring sites is required with the following classifications:

- BRCPs (23) to fundamentally enforce every aspect to be included in the Water Resources Decree.
- Sites at existing dams with the reservoir of more than 10×10^6 cu.m to monitor the inflow and water storage level.
- Sites representative for 80 Sub-Hydrological Areas (SHAs) for evaluation of the surface water potential.

At 434 sites, continuous observation of the water level will be guaranteed in line with the frequent updating of rating curves. The items of water quality and sediment transport will be observed at 123 sites selected among the 434 sites for discharge monitoring.

(d) Monitoring Procedures

Aside from the observation required for day-to-day operations of the project facilities by respective OM Offices, it is suggested that the Regional Water Resources Administration Offices to be newly established will be

responsible for the sustained monitoring work and management in terms of equipment, maintenance and field support under the coordination and direction of the proposed Department of Water Administration, FMWRRD. Part of the actual monitoring work may be entrusted to the RBDAs and SWAs with the required logistics and funds.

(e) Data Processing and Storage

The data observed will be promptly sent to the NWRI for subsequent processing and storage. In addition, the NWRI will be responsible for preparation of the hydrological year books.

Number of the sites proposed for monitoring the climate and surface water is summarized by Region below:

	NW HA-I	NE HA-VII	CW HA-II	CE HA-III/IV	SW HA-VI	SE HA-V/VII	Total
1. Rainfall							
BRCPs	4	1	4	8	2	4	23
Existing Dams	5	4	5	3	3	-	20
SHAs	2	1	9	11	5	7	35
Total	11	6	18	22	10	11	78
2. Evaporation							
BRCPs	4	1	4	8	2	4	23
Existing Dams	5	4	5	3	3	-	20
SHAs	2	2	3	7	5	4	23
Total	11	7	12	18	10	8	66
3. Surface Water Discharge							
BRCPs	4	1	5	8	2	4	23
Existing Dams	15	19	25	26	26	19	130
SHAs	20	26	23	35	53	124	281
Total	39	46	52	69	81	147	434
4. Water Quality/Sediment							
BRCPs	4	1	4	8	2	4	23
Existing Dams	5	4	5	3	3	-	20
SHAs	2	7	9	11	14	37	80
Total	11	12	18	22	19	41	123

(2) Groundwater

Many boreholes or deep wells have been provided by many public and private agencies to date for water supply; however, the resulting management of groundwater resources is uncoordinated and often duplicated and confusing, and also there is insufficient inventory of the groundwater information. In connection with the enforcement of the Water Resources Decree, it is also suggested that the overall management of nationwide groundwater resources will be made through the hierarchy of the Department of Water

Administration, FMWRRD → Regional Water Resources Administration Offices → the NWRI as is similar to that of the surface water. The groundwater monitoring schemes during the NWRMP period will be carried out in the following manner:

(a) Pre-pumping Test for Deep Wells

It is a pre-requisite that when providing a new deep well, the pumping test should be undertaken and documented in line with the detailed specifications for each of the Basement Complex and Sedimentary areas which are prepared and directed by the NWRI.

(b) Data Processing and Storage

Each implementing agency should report the outcome of pumping tests and subsequent groundwater withdrawal from the production wells to the Regional Water Resources Administration Offices for the Federal monitoring of local groundwater behaviors. The technical analysis for proper management of the groundwater resources and the publication of hydrogeological year books will be done by the NWRI.

(c) Provision of Local Groundwater Monitoring Systems

There would be the problem areas for groundwater overdrafting and resultant water table lowering in such urban areas as Maiduguri, Sokoto, Lagos and so on. To make appropriate surveillance, it is imperative to install a system of a series of monitoring wells for proper control of the aquifer hydraulic parameters. In addition, there is the need for the provision of shallow-groundwater monitoring networks to ensure the proposed expansion of private irrigation schemes over the wetlands. Number of the monitoring wells proposed during the NWRMP period is assumed below:

	NW HA-I	NE HA-VII	CW HA-II	CE HA-III/IV	SW HA-VI	SE HA-V/VII	Total
For Aquifers	10	23	-	-	20	15	68
For Private Irrigation	34	47	73	83	21	42	300
Total	44	70	73	83	41	57	368

3.2.2 Water Source Works

(1) General Targets

It has been predicted that the water duty to be given to the water source works by the proposed public irrigation and domestic water supply schemes by the end of the NWRMP period may reach 16.9 × 10^9 cu.m with the breakdown of 13.5 × 10^9 cu.m for irrigation and 3.4 × 10^9 cu.m for water supply. Of this amount, 5.1 × 10^9 cu.m could be supplied from existing water storages, and the remaining 11.8 × 10^9 cu.m by newly proposed water source works. Apart from the primary low-head pumps, about 80 percent of new water sources or 10.0 × 10^9 cu.m will be scheduled to be provided by means of the water storages.

As for the inter-basin water transfer schemes so far provisionally proposed, a review by the JICA Team indicates that although attention has been paid to a Hawal scheme to the Lake Chad Basin, the feasibility of all the schemes would be quite doubtful in economic and environmental terms, and any scheme is not in a position to be included in the NWRMP. It is suggested that more elaborate study on the schemes be made during the NWRMP period taking into account substantial mitigation of problem factors as well as future trend of the Northern drought.

(2) Urgent BMR for Existing Dams

A comprehensive BMR schemes for existing dams and reservoirs should be implemented to ensure the water release of 5.1 × 10^9 cu.m for downstream use of public irrigation and water supply including the establishment of appropriate reservoir operations rules and the urgent rehabilitation of dam structures to maintain their functions including the solution of present dam safety problems. Special attention should be paid to the following two points:

(a) Water Management for Existing Storages

At this stage, almost all of existing water storages are operated without any reservoir operations rule partly due to the less downstream water demand so far developed. In order to achieve the most effective utilization of

existing water storages, the reservoir operations study for each dam should be promptly carried out in parallel with the appropriate demarcation of downstream demand for water releases and the re-surveying of physical parameters for dam and reservoir taking into account (1) a sufficient carry-over capacity for successive dry year(s) and (2) making a normal high water level as low as possible to reduce an excessive evaporation loss.

(b) Artificial Flood Releases for Hadejia-Yobe Wetlands

Reference is made to para. 2.3.2 (2) (c) in this Report. Because of a complex nature in estimating the water demand over the Hadejia-Yobe wetlands, a series of test releases from the upstream Tiga and Challawa Gorge storages in a trial-and-error manner may be one of the most feasible options to identify the volume and timing of artificial flooding through the examination of an interrelationship between surface and shallow-groundwater on the basis of simultaneous hydrological observation work throughout the area. To this end, a flow depletion and conveyance study would be made possible to quantify an appropriate level of the artificial flood releases from the dams. It may be noted that this study should be a model for the recovery of wetlands functions, a result of which could be applied to other cases including those of the Sokoto-Rima wetlands.

(3) Proposed Dams Towards the Year 2020

As is stressed in para. 3.1, a general strategy involved in this NWRMP is to direct the FMWRRD policy from the large-scale schemes to the medium- and small-scale ones. To date, emphasis has been placed upon the building of large-scale dams mostly in the dry north of the country; however, the downstream development has proceeded more slowly. In the NWRMP, a top priority should be given to promote the construction of a series of medium- and small-scale water storages which have the physical dimensions of dam height less than 25 m, reservoir capacity less than 50×10^6 cu.m and irrigation service area less than 3×10^3 ha. More particularly, the following size has been formulated in view of the hydrological information prevailing over the tributary basins:

	North HA-I/VIII	Central HA-II/III/IV	South HA-V/VI/VII
Catchment Area (sq.km)	50 ~ 300	30 ~ 200	20 ~ 100
River Inflow (10^6 cu.m)	10 ~ 60	10 ~ 60	10 ~ 50
Dam Height (m)			
Medium-Size	15 ~ 25	15 ~ 25	15 ~ 20
Small-Size	10 ~ 15	10 ~ 15	less 10
Dam Length (km)	0.3 ~ 1.0	0.3 ~ 1.0	0.2 ~ 0.5
Storage (10^6 cu.m)	6 ~ 30	6 ~ 30	3 ~ 15

Careful examination has been made on the 1:50,000 FSN topographical maps by the JICA Team where it has been identified that in the tributary basins with an area of 2 to 5×10^3 sq.km, there are some of the possible sitings for medium- and small- scale dams with a sufficient coverage of immediate downstream wetlands favorable for gravity irrigation. These dams would be mainly of an earth-fill type with the estimated cost for a medium dam at 100×10^6 Naira and a small dam at 15×10^6 Naira, which could be constructed even on the RBDA's force account basis upon proper establishment of its construction task force together with the possible participation of local people to a great extent.

A series of the proposed medium- and small-scale dams thus provisionally identified together with some large-scale dams which would be constructed at the later stage during the NWRMP period have been included in the NWRMP:

	NW HA-I	NE HA-VII	CW HA-II	CE HA-III/IV	SW HA-VI	SE HA-V/VIII	Total
1. Number of the Proposed Dams							
Large/Medium	14	0	74	92	41	43	264
Small	50	20	230	270	100	150	820
Total	64	20	304	362	141	193	1,084
2. Active Reservoir Capacity (10^6 cu.m)							
Large/Medium	700	0	2,940	3,340	910	970	8,860
Small	250	100	1,150	1,350	500	750	4,100
Total	950	100	4,090	4,690	1,410	1,720	12,960
3. Available Reservoir Water (10^6 cu.m)							
Large/Medium	480	0	2,140	2,350	830	920	6,720
Small	150	60	920	1,080	450	680	3,340
Total	630	60	3,060	3,430	1,280	1,600	10,060

From the above table, it may be understood that a water use rate between active reservoir capacity and available water for release is 78 percent as a national total, and this rate would be a great improvement from the current rate of 54 percent.

Implementing mode of these dams which have been preliminarily identified on the FSN topographical maps and partly confirmed by the short field visit would be suggested as follows:

- Phase 1: Selection of the priority basins.
- Phase 2: Pre-feasibility study of the dam siting in multipurpose nature outlining the dimensions of possible sub-projects.
- Phase 3: A full-scale feasibility study for a series of the dams and relevant service sectors as package program(s) for immediate implementation.

Reference is made to para. (e) of (2) of 2.2.1. The environmental protection and conservation of natural resources related to the water source works projects should be made as an integral part of development, and the objective environmental impact assessment should be considered as a pre-requisite for the approval of development plans and projects. In this respect, a proposal on the technical cooperation program "EIA Study and Environmental Monitoring Program for Dam Projects" to be carried out by the external agency is made with the following objectives:

- EIA study and monitoring of related parameters for representative dam projects: five for existing (Challawa Gorge Watari, Goronyo, Zaria & Alau) and five for proposed (Zungeru, Karaduwa, Garma (1), Mayo Ine & Sendam).
- Preparation of coordinated water and environmental quality baseline data for EIA Study projections.
- Guidelines for EIA Study and environmental management plan inclusive of protection measures.

(4) Cost Allocation of Multipurpose Water Resources Projects

As is stated in para. 3.1, majority of the proposed water storage dams and subsequent water conveyance works will be built in multipurpose nature

by the RBDAs who are executing the partial commercialization policy. When the financial responsibility of a project is divided, its total cost for planning, construction and OM may be allocated among the responsible agencies participated. In this connection, it is duly required to divide the cost of a multipurpose water resources project among the respective project purposes such as irrigation, domestic water supply, flood control, hydropower, fisheries and others.

The procedure for dividing total financial cost among the responsible agencies is called "Cost Allocation". The method commonly adopted in many countries for making the cost allocation is known as the Separable Costs-Remaining Benefit Method which is a procedure for the equitable distribution of the cost of a multipurpose project among the purposes served and provides for an equitable sharing of the savings from multipurpose development among the various purposes included. It is suggested that a practical procedure on cost allocation of various water resources development projects which may be applicable in Nigeria should be formulated and filed as one of the regulations to enforce the Water Resources Decree.

3.2.3 Irrigation and Drainage

(1) General Targets

It is imperative that the irrigation subsector growth to be given during the NWRMP period should be discussed within the crop sector growth from the perspective of food demand and supply in the FGN drive for the attainment of self-sufficiency in the production of most crops. Virtually, the long-term perspective for crop sector growth by 2020 has not been available within the FGN; thus, an irrigation growth scenario to be incorporated into the NWRMP has been examined with particular reference to the World Bank publications concerned with the agricultural sector. To this end, a target area for the irrigated agriculture mostly for rice and maize by 2020 has been taken at 1.5×10^6 ha which has also been distributed to that of the public and private schemes on Regional basis in view of the available resources such as water source works and potential service areas:

(unit: 10^3 ha)

	NW HA-I	NE HA-VII	CW HA-II	CE HA-III/IV	SW HA-VI	SE HA-V/VII	Total
1. Public Irrigation Schemes under FMWRRD - RBDAs							
1.1 Existing Projects							
(1) Complete	8	27	12	2	3	8	70
(2) Incomplete	52	63	43	28	42	22	250
Sub-total	60	90	55	40	45	30	320
1.2 Proposed Projects							
(1) By Water Storages	55	5	240	250	60	95	705
(2) By Pumps and Creeks	5	0	10	15	10	55	95
Sub-total	60	5	250	265	70	150	800
Total	120	95	305	305	115	180	1,120
2. Private Irrigation Schemes under FMANR - State ADPs							
2.1 In 1991	35	98	10	3	0	4	150
2.2 Proposed Expansion	68	94	146	146	43	85	600
2.3 In 2020	75	190	40	40	10	20	380
3. Total Area	195	285	345	345	125	200	1,500

In this NWRMP, the public irrigation schemes have been classified into (1) small-scale with less than 500 ha of the service area, (2) medium of 500 to 3,000 ha and (3) large of more than 3,000 ha in connection with the sizing of proposed water storage schemes and the degree of achieving irrigated agriculture in institutional term. Needless to say, the priority should be given to the quick materialization of existing incomplete public schemes and the steady growth of private irrigation schemes mostly over the wetlands, while the proposed new public schemes mainly composed of small- and medium-scale in association with the proposed water resources development would need a considerable time for preparation towards a full implementation since around 2005.

Attention has been paid to an assumed rate of expanding the area of the private scheme at 20 to 30 $\times$ 10^3 ha per year, most of which will be converted later for inclusion into the proposed public irrigation schemes taking advantage of the increased farmers' familiarity to and experience in irrigated agriculture and also the quick return from public investment. To realize this target that the private irrigation is always practiced ahead of the implementation of public schemes, a close coordination between the FMWRRD and the FMANR should be vigorously promoted.

Some important items to develop the public irrigation schemes under the FMWRRD being departed from current practices are summarized below:

- The present situation indicates that the public irrigation schemes are being undertaken by both of the RBDAs and the State Governments without any clear division for implementation. In view of rather unfavorable irrigation performances of the State schemes with insufficient manpower, it is recommended that all of the public schemes be carried out by the RBDAs in a consistent way, and the State Irrigation Departments be best merged with the ADPs for their strengthening.
- With a view to achieving the partial commercialization policy, the RBDAs will be responsible for delivering the irrigation water to the farm turnouts with the amount and timing as required by the farmers in connection with the appropriate costing arrangement. On the other hand, the subsequent provision and OM of the terminal service network with a standard coverage of 30 ha each will be the responsibility of the Water Users Association (WUA) in line with the agro-allied services to be carried out by the State ADPs. In this respect, it is critically important that closer linkages are developed and established between RBDAs and ADPs to ensure adequate agro-allied services for the clients of the former.
- Comprehensive review on the fact that the ability and initiative of both the Government officials and small farmers have been underestimated has revealed a drastical change in initiating and implementing manner for any irrigation development. In particular, attention has been paid to the official procedures of initiating a public project. It is proposed that when a project is preliminarily identified, the Government campaign will take place for farmers in line with the land tenancy arrangement suitable for development, and the several persons qualified will file a petition requesting that such project is to be executed by the FMWRRD. After this, a feasibility study will be carried out; to this end, a WUA covering the area will be set up for the project implementation. This procedure may be one of the items to be included in the regulations under the Water Resources Decree.
- To date, little attention has been paid to the provision of adequate drainage function within the irrigation area. It is common that the drainage facilities may function to improve the on-farm water management for crop productivity and reduce the occurrence of not only the water-based infections but the rural environmental problems as a whole. Generally speaking, the farmers at an initial stage would not be aware of the seriousness of this problem and

would be reluctant to grant the use of necessary land for drains through their fields. However, drains will be included in the design of on-farm works and could be constructed if they become convinced of the need for them.

(2) Existing Public Schemes

(a) Urgent BMR for Complete Schemes

Of the currently irrigated area of 70×10^3 ha, there are some of the problem areas with the defects of canal system and on-farm works, the lack of drainage system, the difficult maintenance of sprinklers, the poor performance of water management as a whole and so on. These problems should be solved through the urgent implementation of rehabilitation and improvement program for the project facilities together with the organizing of relevant WUAs and the strengthening of agricultural support services, within the context of a Master Action Plan towards 2000.

(b) Development for Incomplete Schemes

Of the total area estimated at 250×10^3 ha nationwide, about 50 percent of this is currently on-going for development. The remainder appears to have no survey and planning of the service area including the large-scale projects such as KRIP II, Middle Rima Valley, Zauro Polder, Upper and Middle Ogun and so forth. It is suggested under the irrigation growth scenario that proper arrangement be made for completion of these projects with a schedule of the feasibility study and detailed design by 2000 and of construction by 2005 in parallel with the establishment of reservoir operations rule for upstream storage and other arrangements relevant to quick achievement of the irrigated agriculture.

(3) Proposed Public Schemes with Storage

About 1,100 irrigation projects are newly proposed in the NWRMP in line with the development of new dams as are explained in para. 3.2.2. These irrigation projects should be carried out in the following manner: